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Scientific and Technical Aerospace Reports

A Semimonthly Publication of the National Aeronautics and Space Administration

June 8, 1963

01 GENERAL

Includes: management; space law and legal matters; symposia or conferences of a broad or a general nature.

N63-14801 Oak Ridge National Lab., Tenn.
INSTRUMENTATION AND CONTROLS DIVISION Annual Progress Report For Period Ending July 1, 1961
C. J. Borkowski and C. S. Harrill Feb. 19, 1962 109 p refs
(Contract W-7405-eng-26)
(ORNL-3191) OTS: $2.25

Instrumentation developments are reported in the following areas: electronic instrumentation for radiation monitoring and nuclear spectroscopy; equipment and methods for data handling and computation; process control instrumentation; reactor-controls-systems design and development; and support instrumentation for the high-voltage accelerator program. M.P.G.

N63-14890 Brookhaven National Lab., Upton, N.Y.
PROGRESS REPORT, NUCLEAR ENGINEERING DEPARTMENT, MAY 1-AUGUST 31, 1962
Warren E. Winsche, F. T. Miles, and Jean H. Reynolds, ed. Jan. 1963 91 p refs
(BNL-759(S-62)) OTS: $2.00

Research is reported by the following divisions: reactor physics, chemistry and chemical engineering, radiation, hot laboratory, metallurgy, and engineering. R.C.M.

N63-14957 Lockheed Missiles and Space Co., Sunnyvale, Calif.
COMPOSITE MATERIALS: AN ANNOTATED BIBLIOGRAPHY
Helen M. Abbott, comp. Feb. 1963 94 p 190 refs
(SB-62-58)

This is an annotated bibliography of 190 selected references pertaining to composite materials. Material composites are broadly considered as physical combinations of two or more dissimilar materials. Boron carbide impregnated with aluminum (Boral), metal fibers in glass or plastics, or glass fibers in aluminum are examples of some of the various combinations that are being studied. Author

N63-14961 Ames Lab., Iowa State U. of Science and Tech.
ANNUAL SUMMARY RESEARCH REPORT IN CHEMISTRY, ENGINEERING, METALLURGY AND PHYSICS, JULY 1, 1961-JUNE 30, 1962
F. H. Spedding et al Sept. 1962 342 p 30 refs
(Contract W-7405-eng-82)
(IS-500) OTS: $4.00

Research in the following areas is summarized: chemistry, engineering, metallurgy, and physics. Abstracts of papers published during the year are included. R.C.M.

02 AERODYNAMICS OF BODIES, COMBINATIONS, AND INTERNAL FLOW

Includes: aerodynamics of channels, cowls, ducts, ejectors, nozzles, etc.

For related information see: 03 Aerodynamics of Wings, Rotors and Control Surfaces; and 11 Fluid Mechanics.

N63-14755 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
STABILITY AND CONTROL CHARACTERISTICS AT SUBSONIC SPEEDS OF A FLAT-TOP ARROWHEAD WING-BODY COMBINATION
Donald A. Buell and Norman S. Johnson Washington, NASA, Mar. 1959 55 p 9 refs
(NASA MEMO 3-5-59A) OTS: $5.60 ph, $1.85 mf (Declassified)

A wind-tunnel investigation was made to determine the longitudinal- and lateral-stability derivatives of a flat-top wing-body configuration at Mach numbers from 0.22 to 0.90 and Reynolds numbers of 3.5 and 17 million. The wing had a leading-edge sweepback of 78.9° and a cathedral of 45° on the outer panels. The tests included the determination of the effectiveness of elevon and rudder controls and also an investigation of ground effects. The model was tested at angles-of-attack up to 28° and angles-of-sideslip up to 18°. The dynamic response of this configuration has been determined from the wind-tunnel data for a simulated airplane having a wing loading of 17.7 pounds per square foot. The longitudinal data show a forward shift in aerodynamic center of 10 percent of the mean aerodynamic chord as the lift coefficient is increased above 0.1. Although flown in the lift range of decreasing stability, the simulated airplane did not encounter pitch-up in maneuvers initiated from steady level flight with zero static margin unless a load factor of 2.2 was exceeded. This maneuver margin was provided by a large value of pitching moment due to pitching velocity. The number of cycles to damp the Dutch-roll mode to half amplitude, the time constants of the roll subsidence and spiral divergence modes, and control effectiveness in roll are computed. The lateral stability is shown to be positive but is marginal in meeting the military specifications for today's aircraft. Author

N63-14757 National Aeronautics and Space Administration. Langley Research Center, Langley Field, Va.

WIND-TUNNEL INVESTIGATION AT MACH NUMBERS FROM 1.60 TO 4.50 OF THE STATIC-STABILITY CHARACTERISTICS OF TWO NONLIFTING VEHICLES SUITABLE FOR REENTRY

Kenneth L. Turner and David S. Shaw Washington, NASA, Mar. 1959 35 p

(NASA MEMO 3-2-59L) OTS: $3.60 ph, $1.25 mf (Declassified)

A static-stability investigation was conducted in the Langley Unitary Plan wind tunnel on models of two nonlifting reentry vehicles. These shapes are designed to use a heat sink and blunt form to combat the high heat rates encountered during reentry. For some of the tests, one of the models was changed by modifying the intersection of the face with the afterbody from a sharp corner to a rounded edge, and the other model was changed by adding a spike at the rear of the model. Tests were performed through an angle-of-attack range from approximately -4° to 184° and a Mach number range of 1.60 to 4.50. The Reynolds numbers per foot ranged from about 1.1×10^6 to 5.8×10^6. The results show that from a static-stability and trim standpoint, either model could successfully be used as a manned vehicle for reentering the earth's atmosphere. No dynamic effects have been taken into consideration. There was little or no effect of Reynolds number, in the range tested, on the axial-force and stability characteristics of any of the test configurations. Author

N63-14758 National Aeronautics and Space Administration. Langley Research Center, Langley Field, Va.

HEATING AND IMPACT TESTS ON INSULATED AND UNINSULATED BALLISTIC-MISSILE FUSE MECHANISMS SUBJECTED TO SIMULATED REENTRY AERODYNAMIC HEATING

Willie L. Nix Washington, NASA, Jan. 1959 23 p 2 refs

(NASA MEMO 12-5-58L) OTS: $2.50 ph, $0.89 mf (Declassified)

Insulated and uninsulated fuse mechanisms of a preliminary design were subjected to simulated reentry aerodynamic heating to determine temperature distributions and the ability of the fuse mechanism after heating to generate a voltage pulse upon impact. Calculations were made to show the temperature distributions in portions of the mechanism where there were no thermocouples. Results of eight tests on four mechanisms indicate that the temperatures in the insulated mechanisms were considerably lower than those for the uninsulated mechanisms, and that the voltage pulses at impact from insulated mechanisms were generally smaller and of shorter duration than those from uninsulated mechanisms. The voltage pulse at elevated temperature for both types of mechanisms was generally smaller than the room-temperature pulse. Author

N63-14762 National Advisory Committee for Aeronautics. Lewis Flight Propulsion Lab., Cleveland, Ohio

INVESTIGATION OF AN AIR-COOLED, PLUG-TYPE, VARIABLE-AREA EXHAUST NOZZLE

G. R. Smolak and W. K. Koffel Washington, NACA, Apr. 10, 1957 39 p 7 refs

(NACA RM E57A07) OTS: $3.60 ph, $1.37 mf (Declassified)

The cooling requirements and internal thrust performance of an air-cooled, plug-type, variable-area exhaust nozzle were experimentally investigated in a turbojet-engine afterburner over a range of exhaust-gas total temperatures from 1990° to 2840° F, and a range of exhaust-nozzle pressure ratios from 1.5 to 10.8. At the highest exhaust-gas total temperature investigated (2840° F), a total nozzle-cooling airflow of 4.5 percent of the afterburner gas flow produced an average plug-surface temperature of 1620° F. The 4.5 percent value comprised about 1.2 percent for plug cooling, 2.6 percent for plug support-strut cooling, and 0.7 percent for outer-shell cooling. The value of the jet-thrust coefficient was constant at about 0.97, over a range of exhaust-nozzle pressure ratios from 1.5 to 10.8, for the full-scale plug nozzle with a smooth fairing on the tailcone. This level of internal thrust performance was good and agreed well with prior NACA model-plug-nozzle data. A loss in jet-thrust coefficient up to 2 percent was caused by roughness (discontinuities and buckles) on the plug tailcone surface. Author

N63-14766 National Aeronautics and Space Administration. Langley Research Center, Langley Field, Va.

FREE-FLIGHT TESTS TO A MACH NUMBER OF 1.5 OF SLENDER TRIANGULAR PYRAMID REENTRY CONFIGURATIONS

Joseph H. Judd and Gerard E. Woodbury Washington, NASA, Mar. 1961 27 p 13 refs

(NASA TM X-437) OTS: $2.60 ph, $1.01 mf (Declassified)

Rocket-propelled triangular configurations have been flown to a Mach number of 1.5 and to Reynolds numbers, based on wing mean aerodynamic chord (two-thirds body length), of 59×10^6. Four small models were flown to a Mach number of 1.2 by the helium-gun technique. Measured lift and pitching-moment-coefficient slopes for small angles were approximately the same as predicted by linearized theory at an average Mach number of 1.45. The models were dynamically stable for small angular disturbances where the rolling velocity was near zero. Author

N63-14781 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

METHOD FOR APPROXIMATING THE VACUUM MOTIONS OF SPINNING SYMMETRICAL BODIES WITH NONCONSTANT SPIN RATES

C. William Martz Washington, NASA, 1961 21 p 6 refs

(NASA TR R-115) GPO: $0.35

A method for approximating the vacuum motions of spinning rigid symmetrical bodies with varying spin rates and inertias has been completed. The analysis includes the effects of time-varying thrust misalinements, mass unbalance, and jet damping. Results are given in the form of equations for space-referenced Euler angles, flight-path angles, body-referenced attitude rates, and earth-referenced vehicle-trajectory coordinates. The general solutions give insight into the separate effects of the variables and, in many cases, can be quickly used to determine the approximate ranges of the variables required for the desired solution to a given problem. In this respect, equations for determining maximum wobble have been derived for certain input conditions. The method has been shown to compare closely with the numerical solutions of two sample problems. The sample problems also illustrated the relatively large effect of pitch and yaw jet damping on body motions. Author

N63-14821 France. Ministère de l'Air, Paris

CONFÉRENCES SUR L'AÉROTHERMIQUE DES ONDES DANS LES MILIEUX RÉACTIFS [CONFERENCE ON THE AEROTHERMICS OF WAVES IN A REACTIVE ATMOSPHERE]

M. A. K. Oppenheim Paris, Service de Documentation et d'Information Technique de l'Aéronautique (SDIT), 1963 78 p 19 refs In French

(*Its* Publications Scientifiques et Techniques No. 392) Available from SDIT, 2, Ave. de la Porte d'Issy, Paris (15e)

After reviewing the influences of transport phenomena, the fundamental equations of aerothermochemistry are established. The equations are then applied to the solution of propagation and structure problems (waves of detonation, laminar flames). The method for treating the problem of interaction between waves of diverse nature and those of completed amplitude are reviewed. Trans. by A.R.B.

N63-14822 France. Ministère de l'Air, Paris

ESSAI DE CALCUL DE LA COUCHE LIMITE TURBULENTE ET DE LA TRANSITION SUR UNE PLAQUE PLANE [A STUDY OF CALCULATIONS OF A TURBULENT BOUNDARY LAYER AND OF THE TRANSITION ON A FLAT PLATE]

R. Hirsch Paris, Service de Documentation et d'Information Technique de l'Aéronautique (SDIT), 1963 191 p refs In French (*Its* Publications Scientifiques et Techniques No. 393) Available from SDIT, 2, Ave. de la Porte d'Issy, Paris (15e)

Studies are made of the boundary layers about a flat plate. Two Navier-Stokes equations for the case of a stationary field next to an intermediate turbulent field are solved. An asymptotic solution is shown to exist, and a universal constant for friction of a flat plate is determined. The transient perturbations form in boundary layers in response to a harmonic perturbation of a wavelength such as exists in the medium surrounding the flat plate. In this case, the Blasius state does not exist, but the application of the solution of the Navier-Stokes shows that the perturbations arising along the length of the segment 1/2 R_c,R_c constitute the transition zone. Finally, the effect of introducing the compressible state in these calculations is examined. M.P.G.

N63-14827 Naval Ordnance Lab., White Oak, Md.

APPROXIMATE ANALYSIS OF EFFECT ON DRAG OF TRUNCATING THE CONICAL NOSE OF A BODY OF REVOLUTION IN SUPERSONIC FLOW

Neal Tetervin Feb. 1963 27 p 7 refs
(NOLTR-62-111; Aerodynamics Res. Rept.-183)

A rapid method for estimation of the nose pressure-drag coefficient in supersonic flow of a body formed by replacing all, or part of, its conical nose by a flat face is given. The analysis, although rough, agrees with the experimental observation that the drag coefficient of a truncated cone of fixed length decreases as the radius of the flat face increases from zero. After reaching a minimum, the drag coefficient rises above that of the sharp-tipped cone. For example, at a Mach number of 2.4, the calculated nose drag coefficient of a truncated cone, obtained from a sharp-tipped cone of 38° included angle by decreasing the cone angle without changing the nose length, decreases to about 93 percent of that of the sharp cone as the flat-face radius increases to 15 percent of the base radius. The drag coefficient of the blunt cone remains less than that for the sharp cone up to a ratio of flat face to base radius of about 28 percent. At a Mach number of 2.4, the calculated nose drag coefficient of a flat-faced cone, obtained from a sharp cone of 38° included angle by decreasing the cone angle, is as much as 19 percent less than the nose drag of the cone of equal flat-face area obtained by keeping the cone angle fixed at 38° and reducing the nose length. The indication from the analysis is that the allowable blunting for no increase in drag over the sharp cone decreases slowly with increase in Mach number and more rapidly with decrease in sharp cone angle. Author

N63-14830 Imperial Coll. of Science and Tech., London (Gt. Brit.)

COMPUTOR SOLUTIONS TO THE PROBLEM OF VIBRATIONAL RELAXATION IN HYPERSONIC NOZZLE FLOWS

J. L. Stollery and C. Park Jan. 1963 42 p 27 refs
(Rept. 115)

This report is an extension of an earlier note in which a simple method of estimating the distribution of vibrational temperature along a hypersonic nozzle was described. Results were presented for hyperbolic, axisymmetric nozzles with reservoir conditions $1,000 \leq p_o \leq 4,000$ p.s.i.a; $1,000 \leq T_o \leq 3,000°$ K. The problem was subsequently programed for the Ferranti Mercury computer at the University of London computing center, and the results of these computations are given here. The vibrational temperatures are compared with those of the previous simple method. The distributions of pressure and temperature through the nozzle are also given, and a simple method of estimating the vibrational temperature is described. Author

N63-14832 Aerospace Corp., El Segundo, Calif.

AN ANALYSIS OF THE EFFECT OF HETEROGENEOUS REACTION KINETICS ON THE COMBUSTION OF GRAPHITE AT THE STAGNATION REGION OF A BLUNT BODY IN HYPERSONIC FLOW

W. E. Welsh, Jr., and P. M. Chung Feb. 28, 1963 29 p 8 refs
(Contract AF 04(695)-169)
(TDR-169(3230-12)TN-6; SSD-TDR-63-40)

An approximate analysis is performed for the combustion rate of carbon in air at the stagnation region of a blunt body in hypersonic flow for the intermediate regime of conditions between the reaction-kinetic-limited and the diffusion-limited extremes. The effect of mass addition to the boundary layer caused by the combustion is considered. Combustion rates in the intermediate regime are derived using closed-form approximations for available boundary-layer analyses. The results, shown in a generalized form, are valid for arbitrary reaction kinetics and combustion products. The limitations of the series-resistance approach are demonstrated. A numerical comparison of the closed-form results for the mass loss rates in the diffusion-limited regime and the recent results of Scala indicate that the present simplifications are satisfactory for engineering purposes. Author

N63-14844 Toronto U. Inst. of Aerophysics (Canada)

AERODYNAMIC INSTABILITY OF NON-LIFTING BODIES TOWED BENEATH AN AIRCRAFT

Bernard Etkin and Jean C. Mackworth Jan. 1963 60 p 3 refs (Supported by the Ontario Hydro Electric Power Commission)
(UTIA-TN-65)

A theoretical and experimental (wind tunnel) investigation was made of the stability of a heavy body towed on a light cable beneath an aircraft. The theory showed the possible existence of a band of speeds within which the body is dynamically unstable (swinging sideways). The experiments confirmed this prediction, and showed good agreement with the calculated values of the two critical speeds which bound the unstable region. The calculated and measured periods of oscillation also were in good agreement. Author

N63-14871 National Aeronautics and Space Administration. Langley Research Center, Langley Field, Va.

COLLECTION OF ZERO-LIFT DRAG DATA ON BODIES OF REVOLUTION FROM FREE-FLIGHT INVESTIGATIONS

William E. Stoney, Jr. Washington, NASA, 1961 190 p 32 refs
(NASA TR R-100; supersedes NACA TN-4201) GPO: $1.75

A compilation is made of most of the zero-lift drag results obtained from free-flight measurements made by the Langley Pilotless Aircraft Research Decision on fin-stabilized bodies of revolution. The data are arranged on standard forms, which also contain the significant geometrical factors. Supplementary data have been provided to facilitate the determination of the body pressure drags from the measured total drags. Summary plots and discussions have been included to provide a unified and broad picture of the effects of body geometry on zero-lift drag. Author

N63-14872 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

THEORETICAL PREDICTION OF THE EFFECTS OF VORTEX FLOWS ON THE LOADING, FORCES, AND MOMENTS OF SLENDER AIRCRAFT

J. Richard Spahr Washington, NASA, 1961 40 p 19 refs
(NASA TR R-101) GPO: $0.45

A general calculative method based on slender-body theory is developed for predicting the paths of vortices in the presence of wing-body combinations at subsonic, transonic, and supersonic speeds, and the influence of the vortices on the loading, forces, and moments acting on the combinations. The method is applied to wing-body combinations to study the effects of vortex strength and

initial position, combined angles of pitch and roll and wing aspect ratio on the vortex paths and induced loads. The results indicate that these effects were significant because of the dependence of the vortex paths and induced loads on the vortex strengths and on the proximity of the vortices to the surface of a wing-body combination. Comparisons of theoretical and experimental results indicated that the vortex paths and vortex-induced forces and moments for slender-wing-body combinations were closely predicted by the slender-body method but for nonslender combinations these characteristics were only approximated. The application of an alternate method based on reverse-flow theory improved the predictions of the vortex-induced forces and moments for the latter combinations but impaired those for slender combinations. The induced forces and moments on the nonslender combinations were sufficiently small that the total forces and moments could be predicted adequately through the use of either method. Author

N63-14895 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

A SURVEY OF AEROTHERMOELASTICITY

I. E. Garrick Repr. from Aerospace Eng., v. 22, no. 1, Jan. 1963 p 140–147 17 refs

Some of the known problem areas of aerothermoelasticity are enumerated, and methods of obtaining quantitative information for attacking these problems are discussed. D.E.R.

N63-14960 Aeronautical Systems Div. Flight-Dynamics Lab., Wright-Patterson AFB, Ohio

FREE FLIGHT SCALE MODEL TECHNIQUE FOR STUDYING ADVANCED CREW ESCAPE SYSTEM CONFIGURATIONS

George W. Ducker and Ezekiel L. Smith Apr. 1962 27 p 6 refs (ASRMDD-TM-62-32)

A technique utilizing the principle of small-scale dynamic-model testing for configuration evaluation of advanced crew-escape systems is presented. The basic laws of dynamic similitude are the foundation for this study. A number of test series are presented, with results, discussions, and conclusions. Photographs of the test equipment, model samples, and test procedures are included. Author

N63-14972 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

LAMINAR BOUNDARY-LAYER SEPARATION INDUCED BY FLARES ON CYLINDERS AT ZERO ANGLE OF ATTACK

Donald M. Kuehn Washington, NASA, 1962 17 p 7 refs (NASA TR R-146) GPO: $0.30

Laminar boundary-layer separation induced by conical flares on cylindrical bodies of revolution has been experimentally investigated in the Mach number range of 2.0 to 5.5 at Reynolds numbers, based on boundary-layer thickness, from 1×10^3 to 30×10^3. Geometric variables were nose shape, cylinder length, and flare angle; test variables were Mach number, Reynolds number, and heat transfer. The purpose of the investigation was to determine which of these variables most influences laminar boundary-layer separation on cylinder-flare configurations and to provide data that will aid in the prediction of laminar separation. The results showed that the tendency toward laminar separation decreased as Mach number or heat transfer to the model was increased and as Reynolds number or flare angle was decreased. Cylinder length and nose shape had no influence on the variation of Mach number for incipient separation with Reynolds number based upon boundary-layer thickness. Conditions for incipient separation on blunt- and sharp-nosed cylinders corrected, whether determined from properties in the free stream or at the model surface. Author

N63-15183 General Electric Co. Space Sciences Lab., Philadelphia, Pa.

SOME EXPLORATORY PRESSURE MEASUREMENTS ON A BLUNT PLATE WITH A NON-EQUILIBRIUM FLOW FIELD

R. E. Geiger Jan. 1963 33 p 20 refs (Contract AF 04(694)-222) (R63SD13)

A series of exploratory pressure measurements have been made in the G.E. Space Sciences Laboratory's 30-in. shock tunnel, on a cylindrically blunted flat plate, at conditions where the expanding part of the model flow field is expected to be chemically frozen, but where earlier nozzle static-pressure data indicate the test-section flow to be nearly in equilibrium. Analysis of the data and comparison with exact equilibrium flow-field solution provided by Fitzgibbon and Edsall indicate that: (1) The expanding section of the model flow field is largely, perhaps completely, frozen. (2) As a consequence, pressures behind the nose are significantly lower than for an equilibrium flow field resulting in a somewhat smaller loss of C_L and L/D at low angles-of-attack. (3) Flow separation renders impossible firm conclusions as to the nonequilibrium effects on the effectiveness of a windward deflected leading edge flap-type control; however, the data suggest reduced effectiveness at zero angle-of-attack for 10° and 20° deflections. (4) The frozen blast-wave approach, which uses a reduced nose drag coefficient determined by the amount of frozen energy in the flow field, appears a promising means of predicting blunt nose induced pressures when the expanding body flow is frozen, though more experiments are needed before firm conclusions can be drawn. Author

03 AERODYNAMICS OF WINGS, ROTORS, AND CONTROL SURFACES

Includes: ailerons; airfoil sections; cascades; fans; flaps; propellers; rotors; slats; spoilers; etc.

For related information see: 02 Aerodynamics of Bodies, Combinations, and Internal Flow; and 11 Fluid Mechanics.

N63-14921 Brown U. Div. of Engineering, Providence, R. I.

UNIFORM SECOND-ORDER SOLUTION FOR SUPERSONIC FLOW OVER DELTA WING USING REVERSE-FLOW INTEGRAL METHOD

Joseph H. Clarke and James Wallace Apr. 1963 30 p 13 refs (Contract NOw-62-0604-c; Proj. Bumblebee) (CM-1034)

The problem of supersonic flow over an inclined flat-plate delta wing with supersonic edges is solved to second order in incidence. This solution for surface pressure is uniform and fully analytic. The approach utilizes a reverse-flow integral method previously developed for second-order problems. This method is augmented by a number of techniques appropriate to its framework. The simplification over standard techniques achieved by using these reverse-flow methods is quite substantial and makes the problem tractible. Reverse-flow procedures give a volume-surface integral relation that connects the second-order foward flow over the body of interest with the linearized reverse-flow over a related body. A singular integral equation is generated from the integral relation by introducing the edge sweep of the reverse-flow wing as a free parameter. An inversion is available which gives the second-order solution on the surface of the wing. The solution is then made uniformly valid using techniques previously developed. Author

N63-14964 Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge

THE MAGNETOHYDRODYNAMIC FLOW PAST A NONCONDUCTING FLAT PLATE IN THE PRESENCE OF A TRANSVERSE MAGNETIC FIELD

Donald M. Dix (Ph. D. Thesis) July 9, 1962 135 p 26 refs
(Contract DA-36-039-sc-78108 and DA-SIG-36-039-61-G14; NSF Grant G-9330)
(MIT-TR-397)

The general character of the magnetohydrodynamic flow past a nonconducting flat plate in the presence of transverse magnetic fields is analyzed in some detail. The appropriate extension of the Rayleigh problem to the magnetohydrodynamic case is shown to yield solutions that correctly predict some features of the steady flow past a semi-infinite flat plate. Also, it is shown that the knowledge of these significant features permits an easy evaluation of their magnitudes in other extensions of the Rayleigh problem. The flow past a semi-infinite flat plate is analyzed by two methods. First, by linearizing the governing equations and incorporating the assumption of a low ratio of viscous-to-magnetic diffusivity, the results for skin friction and the normal component of magnetic field at the plate are obtained, and are shown to be useful in interpreting the character of these low conductivity flows. Second, the complete set of governing equations is formulated as a finite difference problem and solved numerically on a digital computer. The results obtained show that the disturbance produced by the plate is no longer confined to a thin viscous layer if the ratio of viscous-to-magnetic diffusivity is greater than 10^{-2}, but that an appreciable Alfven type of disturbance is excited. Author

N63-15088 Kellett Aircraft Corp., Willow Grove, Pa.
ON THE AERODYNAMIC DESIGN OF PROPELLERS AND DUCT SYSTEMS FOR GROUND EFFECT VEHICLES [Final Report]
Richard R. Pruyn, A. A. Perlmutter, and N. Miller Jan. 15, 1962 135 p 16 refs
(Contract DA-44-177-TC-524)
(Rept. 208A90-1)

Analytical and experimental studies have been made to establish a method for the design of propellers and duct systems for annular-jet ground effect machines. Propeller and inlet geometry and the effects of nozzle velocity distribution on annular-jet performance were analyzed. Experimental investigations included tests of an axisymmetric duct and a curved duct at various ground board heights and inclinations. Overall and detailed internal efficiencies were determined and are compared with the analysis. Author

N63-15173 Cornell U. Graduate School of Aerospace Engineering, Ithaca, N.Y.
A THEORY FOR UNSTEADY MOTIONS OF JET-FLAPPED THIN AIRFOILS
John Clifford Erickson, Jr. Sept. 1962 207 p 48 refs
(Contract AF 49(638)-544)

A linearized model for the incompressible, inviscid, irrotational, and unsteady flow about a thin airfoil with jet-flap is formulated. The unsteady problems considered are the transient and oscillatory deflection of the jet, plunging and pitching of the airfoil, deflection of a "blown-flap," and also the penetration of a sharp-edged gust. Justification is given for representation of the jet, in the limit of high speed, small thickness, and constant momentum-flux strength, by a vortex sheet, across which there is a pressure difference proportional to the momentum-flux strength and inversely proportional to the local radius of curvature of the jet. The dynamic and kinematic interaction of the main stream with the vortex sheets representing the airfoil and jet are shown to be described by a coupled set of equations consisting of a third-order partial differential equation and a singular integral equation, along with appropriate boundary conditions. The properties of these equations and their relationship to classical unsteady thin-airfoil theory and steady jet-flap theory are discussed. Author

N63-15235 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
AERODYNAMIC CHARACTERISTICS OF A FLEXIBLE-CANOPY PARAGLIDER MODEL AT A MACH NUMBER OF 4.5 FOR ANGLES OF ATTACK TO 360° AND SIDESLIP ANGLES FROM 0° TO 90°
Dewey E. Wornom and Robert T. Taylor Apr. 1963 26 p 7 refs
(NASA TN D-1776) OTS: $0.75

Force tests of a flexible-canopy paraglider model with a rigid frame have been conducted at a Mach number of 4.5 in the 2-foot hypersonic facility at the Langley Research Center. The aerodynamic characteristics were measured over an angle-of-attack range from 0° to 360°, for sideslip angles from 0° to 90°, at a Reynolds number of approximately 0.3×10^6 based on a model keel length of 5.75 inches. The variations of the aerodynamic coefficients with angle-of-attack at constant sideslip angles are presented with limited discussion. For the moment reference center selected, the data at zero sideslip showed that longitudinal trim occurred at an angle-of-attack of 45.5°, with a corresponding lift coefficient of 0.45 and a lift-drag ratio of 0.94. A maximum lift coefficient of 0.79 was obtained at an angle-of-attack of 68°. From visual observations of canopy action during the tests, abrupt load reversal was noted to occur around an angle-of-attack of 180°. Author

04 AIRCRAFT

Includes: specific types of complete aircraft (e.g., Ground Effects Machines, Flexible Wings, STOL, and VTOL); flight tests; operating problems; stability and control.

For related information see: **02 Aerodynamics of Bodies, Combinations, and Internal Flow; 03 Aerodynamics of Wings, Rotors, and Control Surfaces; and 30 Space Vehicles.**

N63-14767 National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.
CONTROLLABILITY OF THE X-15 RESEARCH AIRPLANE WITH INTERIM ENGINES DURING HIGH-ALTITUDE FLIGHTS
Euclid C. Holleman and Donald Reisert Washington, NASA, Mar. 1961 22 p 4 refs
(NASA TM X-514) OTS: $2.60 ph, $0.86 mf (Declassified)

As part of a general flight-test program designed to demonstrate the flight envelope of the X-15 airplane with interim low-thrust engines, flight to high altitude with low dynamic pressure was accomplished. A peak geometric altitude of 136,500 feet with a minimum dynamic pressure of 10.6 lb/sq ft was attained, with only the aerodynamic controls available to the pilot for controlling and stabilizing the airplane. Aerodynamic control was adequate throughout the flight, but at minimum dynamic pressure the airplane was lightly damped, which made precise control difficult. Because of the transient nature of the trajectory and the negligible load factors associated with the airplane oscillation, the pilot did not object to the poor dynamic characteristics of the airplane under these conditions and could satisfactorily control the airplane along the trajectory. Author

N63-14788 Cornell Aeronautical Lab., Inc., Buffalo, N.Y.
CRITERIA FOR ACCEPTABLE REPRESENTATION OF AIRPLANE DYNAMIC RESPONSES IN SIMULATORS USED FOR PILOT TRAINING Technical Report
F. D. Newell Oct. 1962 85 p 16 refs
(Contract N61339-1146)
(NAVTRADEVCEN-1146-1)

Disparities between the handling (flying) characteristics of aircraft and those of Aviation Weapons System Trainers (simulators of aircraft) are discussed and analyzed. It is found that the simulators represent the static characteristics of flight very well but

do not always give adequate simulation of the transient response characteristics of aircraft. Criteria for adequate simulation of these characteristics are presented. D.E.R.

N63-14993 Directorate of Engineering Test, Aeronautical Systems Div., Wright-Patterson AFB, Ohio
FLIGHT VIBRATION SURVEY OF C-130A AIRCRAFT [Final Report]
Charles E. Thomas Mar. 1962 44 p
(ASD-TDR-62-267)

A C-130A aircraft, SN 53-3133, was surveyed at Wright-Patterson Air Force Base, Ohio, to determine the vibration environment existing throughout the vehicle under all flight conditions expected in service. Approximately 50,700 data points were obtained from 21 separate locations on the vehicle during five test flights. The data obtained in this survey were evaluated to determine the adequacy of vibration-test requirements for aircraft equipment as contained in Specification No. Mil-E-5272C. The data indicated that the vibration testing requirements of that specification were more than adequate, with the exception of the very light pieces of equipment which are attached to the fuselage sidewalls in the vicinity of the prop plane. Author

N63-15046 North American Aviation, Inc., Columbus, Ohio
AN INVESTIGATION OF LOW-ALTITUDE, HIGH SPEED FLYING AND RIDING QUALITIES OF AIRCRAFT
Ralph C. A'Harrah and Richard P. Schulze Feb. 1963 122 p
(Contract NOw-61-0699-d)
(NA-62H-397)

The results of a combined flight program and ground-based dynamic flight-simulator study of the handling and riding qualities problems associated with low-altitude, high-speed flight are presented. Wide variations of longitudinal stability and control characteristics were pilot-evaluated, and pilot performance was measured for a terrain following task flown at varying levels of atmospheric turbulence. Pilot iso-opinion mappings of longitudinal static and dynamic stability for various control systems are shown, with regions exhibiting pilot-induced oscillation (PIO) tendencies denoted. Pilot tolerance to gust-induced acceleration is established along with the influence of stability, control, and turbulence on pilot performance. Author

N63-15050 National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.
WING AND FLAP LOADS OBTAINED FROM A WIND-TUNNEL INVESTIGATION OF LARGE-SCALE V/STOL MODEL
Robert J. Huston, John F. Ward, and Matthew M. Winston Washington, NASA, Apr. 1963 90 p 10 refs
(NASA TN D-1634) OTS: $2.25

Wing and flap loads on tilt-wing, tilt-wing-with-slat, and deflected-slipstream configurations, obtained during tests of a large-scale model in the Langley full-scale wind tunnel, are presented for an angle-of-attack range corresponding to transition flight of a vertical or short takeoff and landing (V/STOL) aircraft. Included are wing root moments and shears, flap forces and moments, and partial-span wing pressure distributions for a range of flap deflections and lift-drag conditions corresponding to longitudinal acceleration and deceleration. The relationship between angle-of-attack and normal or chordwise bending moments at the root was found to be basically a cosine or sine function, respectively, but became modified significantly by the flow condition on the wing and by the balance of longitudinal forces. Normal and chordwise bending moments were relatively unaffected by deflection of the 30-percent-chord flaps; in contrast, the wing torsion was substantially affected by flap deflection and by the balance of longitudinal forces. Local areas of flow separation, principally behind upward traveling propeller blades, caused erratic movements in the spanwise centers of pressure. The addition of a 19-percent-chord partial-span slat to the tilt-wing configuration, in combination with 30° of flap deflection, resulted in the elimination of buffet caused by local areas of flow separation for the range of conditions covered. Author

N63-15071 Army Electronics Research and Development Activity. Meteorological Support Div., White Sands Missile Range, N. Mex.
METEOROLOGICAL DATA REPORT, NIKE-APACHE SR-007
Gordon L. Dunaway Mar. 1963 32 p 1 ref
(ERDA-9)

Meteorological data gathered for the launching of Nike-Apache SR-007 are presented for the Ballistic Systems Division, U.S. Air Force, and for ballistic studies. The data appear, along with calculated ballistic data, in appendixes. Author

N63-15227 Electro-Optical Systems, Inc., Pasadena, Calif.
FEASIBILITY OF, A SOLAR ENERGY DEVICE. PART I: DESIGN AND PERFORMANCE CONSIDERATIONS
Frederic E. Fuller Wright-Patterson AFB, Ohio, Aeronautical Research Labs., June 1962 164 p 34 refs
(Contract AF 33(616)-5977)
(ARL-62-360, Pt. I)

The feasibility of a solar-powered aircraft is investigated. The configuration is a high-aspect-ratio flying wing with ramjet thrust. A statement is made with respect to feasibility, with a recommendation of a program for further work. The statement of feasibility is supported by experimental investigation of solar-radiation collection and inlet air diffusion and by design and performance analyses. Author

05 ASTRONOMY AND ASTROPHYSICS

Includes: celestial mechanics; and radioastronomy.

For related information see: 12 Geophysics; and 29 Space Sciences.

N63-14727 Centro di Studio per la Fisica delle Microonde, Florence (Italy)
METEOR DATA BULLETIN NO. 10, SEPTEMBER 1961
Nello Carrara et al Nov. 1962 12 p 23 refs
(Sponsored in part by USAF and Consiglio Nazl. delle Ric., Italy)

Meteor radar data obtained in September, 1961, is presented. The hourly rate is analyzed as a function of the time, antenna direction, and radar distance. Distributions of the echo duration and the duty cycle are computed and particular behavior is observed. D.E.R.

N63-14728 Centro di Studio per la Fisica delle Microonde, Florence (Italy)
METEOR DATA BULLETIN NO. 11, DECEMBER 1961
Nello Carrara et al Nov. 1962 18 p 26 refs
(Sponsored in part by USAF and Consiglio Nazl. delle Ric., Italy)

Meteor radar data obtained in December, 1961, is presented. The hourly rate is analyzed as a function of the time, antenna direction, and radar distance. Distributions of the echo duration and the duty cycle are computed and particular behavior is observed. D.E.R.

N63-14729 Centro di Studio per la Fisica delle Microonde, Florence (Italy)
METEOR DATA BULLETIN NO. 12, JUNE 1962
Nello Carrara et al Feb. 1963 19 p 28 refs
(Sponsored in part by USAF and Consiglio Nazl. delle Ric., Italy)

Meteor radar data obtained at the Centro Microonde at Florence, Italy, in June 1962 is reported. From the data, the hourly

rate is analyzed as a function of the time, antenna direction, and radar distance. The distribution of the echo duration and the duty cycle are computed. Also reported are hourly rate variations during the day, azimuth distribution, drifting and diffused echoes, and echoes with particular evolution. A.R.B.

N63-14730 Centro di Studio per la Fisica delle Microonde, Florence (Italy)

METEOR DATA BULLETIN NO. 13, JULY 1962

Nello Carrara et al Feb. 1963 19 p 30 refs

(Sponsored in part by USAF and Consiglio Nazl. delle Ric., Italy)

Meteor radar data obtained at the Centro Microonde at Florence, Italy, in July 1962 is reported. From the data, the hourly rate is analyzed as a function of the time, antenna direction, and radar distance. The distribution of the echo duration and the duty cycle are computed. Also reported are hourly rate variations during the day, azimuth distribution, drifting and diffused echoes, and echoes with particular evolution. A.R.B.

N63-14731 Centro di Studio per la Fisica delle Microonde, Florence (Italy)

METEOR DATA BULLETIN NO. 14, SEPTEMBER 1962

Nello Carrara et al Feb. 1963 18 p 31 refs

(Sponsored in part by USAF and Consiglio Nazl. delle Ric., Italy)

Meteor radar data obtained at the Centro Microonde at Florence, Italy, in September 1962 is reported. From the data, the hourly rate is analyzed as a function of the time, antenna direction, and radar distance. The distribution of the echo duration and the duty cycle are computed. Also reported are hourly rate variations during the day, azimuth distribution, drifting and diffused echoes, and echoes with particular evolution. A.R.B.

N63-14736 Naval Research Lab., Washington, D.C.

REPORT OF NRL PROGRESS

Mar. 1963 50 p 87 refs

OTS: $1.25

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2. NEW PRINCIPLES FOR FRACTURE-SAFE DESIGN OF STEEL STRUCTURES W. S. Pellini and P. P. Puzak p 9–48 62 refs (See N63-14738 11-34)

N63-14737 Naval Research Lab., Washington, D.C.

NRL PROGRESS IN RADIO ASTRONOMY (1961-1962)

E. F. Mc Clain *In its* Report of NRL Progress Mar. 1963 p 1–8 25 refs (See N63-14736 11-05) OTS: $1.25

Recent progress in radio astronomy at NRL is reviewed. Important observational results have been obtained from studies of planetary radiation and from studies of the brightness and polarization of radio stars. Significant advances in instrumentation have included maser development and improved receiver sensitivity. Author

N63-14855 Manchester U. (Gt. Brit.)

STUDIES IN LUNAR TOPOGRAPHY, NO. 9. (LUNAR SHADOW MEASURING TECHNIQUES AND TABULATED RESULTS FOR THREE CRATERS) Technical Note No. 2

T. W. Rackham May 8, 1962 71 p

(Contract AF 61(052)-496)

The first part of this paper is concerned with methods of assessing the lengths of lunar shadows derived from microdensitometric tracings. Errors arising from atmospheric image distortion and positional uncertainties are discussed. The latter part of this work contains tabulated topographical data for the craters Tycho, Copernicus, and Theophilus. Author

N63-14901 High Altitude Observatory, Boulder, Colo.

WHITE-LIGHT VS. NARROW-BAND OBSERVATIONS OF THE POLARIZATION OF THE ZODIACAL LIGHT

J. L. Weinberg (Colorado U.) Apr. 1, 1963 9 p 2 refs Submitted for Publication

(NASA Grants NsG-15-59 and NsG-135-61)

OTS: $1.10 ph, $0.80 mf

A degree of polarization which is not characteristic of zodiacal light results from improper correction of sky brightness observations of the airglow line and continuum components. Uncertain or unknown absolute intensities of the airglow lines, bands, and continua make measurements of white light with a polarimeter subject to considerable error. Corrections are difficult, even when a narrow band filter is used. But by observations with a bifringent monochromator, used simultaneously with the polarimeter, the difficulty of zodiacal light observations is partly obviated. D.E.R.

N63-15077 Arizona U. Lunar and Planetary Lab., Tucson

COMMUNICATIONS OF THE LUNAR AND PLANETARY LABORATORY, VOLUME I, NUMBERS 17-23

Gerard P. Kuiper and Alika K. Herring 1962 68 p 147 refs For Vol. I, Nos. 7–10 see N62-16618 17-28; for Vol. I, No. 11 see N62-16699 17-28; for Vol. I, Nos. 12–13 see N62-16619 17-28; and for Vol. I, Nos. 14–16 see N63-14008 09-05

(NASA Grant NsG-161-61)

OTS: $6.60 ph, $2.24 mf

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4. THE COMPOSITION ANOMALIES OF 3 CENTAURI A S. Bashkin and B. M. Middlehurst p 155-159 36 refs (See N63-15081 11-05)
5. SURFACE PHOTOMETRY OF EXTENDED IMAGES B. M. Middlehurst p 161-165 58 refs (See N63-15082 11-05)
6. THE WAVELENGTH DEPENDENCE OF POLARIZATION T. Gehrels and T. M. Teska p 167-177 25 refs (See N63-15083 11-05)
7. INFRARED SPECTRA OF STARS AND PLANETS. II. WATER VAPOR IN OMICRON CETI G. P. Kuiper p 179-188 2 refs (See N63-15084 11-05)

N63-15078 Arizona U. Lunar and Planetary Lab., Tucson

PHOTOMETRIC STUDIES OF ASTEROIDS. IX. ADDITIONAL LIGHT CURVES

D. Owings (Indiana U.) and T. Gehrels *In its* Communications of the Lunar and Planetary Laboratory, Vol. I, No. 17, Sept. 25, 1961 p 129–146 22 refs Repr. from Astrophys. J., v. 135, 1962 p 906–924 (See N63-15077 11-05) OTS: $6.60 ph, $2.24 mf

(Sponsored by NSF)

Fifteen asteroids were observed with the 36- and the 82-inch telescopes of the McDonald Observatory. Owing to the fast motions of the 36-inch, precise transfers to the U, B, V system could be made concurrently with the light-curve observations. Iris was observed nearly pole-on, at 8^h5^m right ascension and + 20° declination. Large obliquities often occur, and there apparently is some alignment of the poles. The ecliptic longitudes of eight asteroid poles were determined between 104° (284°) and 194° (14°), with none occurring between 14° and 104° or between 194° and 284°. Author

N63-15079 Arizona U. Lunar and Planetary Lab., Tucson

PHOTOMETRIC STUDIES OF ASTEROIDS. X

H. John Wood (Indiana U.) and Gerard P. Kuiper *In its* Communications of the Lunar and Planetary Laboratory, Vol. I, No. 18, Aug. 6, 1962 p 147–153 4 refs Submitted for Publication (See N63-15077 11-05) OTS: $6.60 ph, $2.24 mf

Pallas was observed photoelectrically on three nights in August 1956, with the McDonald 82-inch reflector. A period of $10^h\,40^m$ has been derived. Asteroids 61 and 11 were observed on four nights in December 1959 to January 1960, with the McDonald 36-inch telescope. The period of 61 is $11^h27^m \pm 5^m$. A brief discussion of the colors of asteroids is included. Author

N63-15080 Arizona U. Lunar and Planetary Lab., Tucson
PRELIMINARY DRAWINGS OF LUNAR LIMB AREAS. III
Alika K. Herring *In its* Communications of the Lunar and Planetary Laboratory, Vol. I, No. 19, Sept. 25, 1962 p 154 (See N63-15077 11-05) OTS: $6.60 ph, $2.24 mf

Preliminary drawings of the limb areas of the moon are presented as a supplement to the photographic *Rectified Lunar Atlas*. Preliminary drawings of areas 10 and 16 which contain the Otto Struve and the Mare Orientale are included along with rectified photographs and key charts of the areas. A stereoscopic drawing of the Mare Orientale is reproduced to emphasize the several concentric fault scraps that have this basin as their center. R.C.M.

N63-15081 Arizona U. Lunar and Planetary Lab., Tucson
THE COMPOSITION ANOMALIES OF 3 CENTAURI A
Stanley Bashkin and Barbara M. Middlehurst *In its* Communications of the Lunar and Planetary Laboratory, Vol. I, No. 20, Dec. 3, 1962 p 155–159 36 refs (See N63-15077 11-05) OTS: $6.60 ph, $2.24 mf

The possible causes of composition anomalies in stars are discussed with particular reference to data obtained from observations of 3 Centauri A. The causes considered include: mass loss resulting in exposure of regions usually masked by the atmosphere; accretion; mixing; special conditions at the surface, past or present; and prestellar environmental anomalies. It is concluded that fluctuations in the composition of the prestellar matter may be a major cause in determining a star's present anomalous atmospheric chemical composition. R.C.M.

N63-15082 Arizona U. Lunar and Planetary Lab., Tucson
SURFACE PHOTOMETRY OF EXTENDED IMAGES
Barbara M. Middlehurst *In its* Communications of the Lunar and Planetary Laboratory, Vol. I, No. 21, Dec. 11, 1962 p 161–165 58 refs Publ. as part of chapter 17, Astron. Techniques (Chicago, Chicago U. Press) in 1962 (See N63-15077 11-05) OTS: $6.60 ph, $2.24 mf

Photometric methods are discussed for determining the shape and distribution of relative or absolute intensities over the surface of extended images, such as planetary nebulae, galaxies, and bright interstellar matter. The methods discussed include photometric tracing, out-of-focus photometry, and isophotometry. The Williams-Hiltner isophotometer (microdensitometer) is discussed and a reprint of O. Mohler's description of the instrument is included. Sample tracings of type S0 galaxy NGC 1291 and barred spiral NGC 1365 made with the Griboval isophotometer are discussed. R.C.M.

N63-15083 Arizona U. Lunar and Planetary Lab., Tucson
THE WAVELENGTH DEPENDENCE OF POLARIZATION
Thomas Gehrels and Thomas M. Teska *In its* Communications of the Lunar and Planetary Laboratory, Vol. I, No. 22, May 15, 1962 p 167–177 25 refs Repr. from Appl. Optics, v. 2, Jan. 1963 p 67 (See N63-15077 11-05) OTS: $6.60 ph, $2.24 mf

Preliminary results are described of a program of polarimetry and photometry. Astronomical telescopes and a differential polarimeter are used with calibration by a Lyot depolarizer. The wide-band filters have effective wavelengths between 3250 Å and 9900 Å. The problems of instrumental polarization and depolarization are discussed; most of the instrumental effects can be avoided by proper aluminization of the telescope mirrors. The multiple molecular scattering of the sunlit sky and of the poles of Jupiter is closely represented by the Rayleigh-Chandrasekhar theory; the optical depth at the Jovian poles is 0.4 to 0.8. The same particle sizes that explain the interstellar reddening, 0.05 to 0.3 μ, are found from the interstellar polarization. Strong polarization-wavelength dependence is found for Venus and for lunar regions, but the detailed explanations require extension of the wavelength range. The range of wavelengths will be extended by using high-altitude balloons and spacecraft. Author

N63-15084 Arizona U. Lunar and Planetary Lab., Tucson
INFRARED SPECTRA OF STARS AND PLANETS. II. WATER VAPOR IN OMICRON CETI
Gerard P. Kuiper *In its* Communications of the Lunar and Planetary Laboratory, Vol. I, No. 23, Jan. 29, 1963 p 179–188 2 refs (See N63-15077 11-05) OTS: $6.60 ph, $2.24 mf

Spectrographs of Omicron Ceti are presented which indicate the presence of water vapor in this variable star. Normally, the water vapor bands at 1.13 μ, 1.38 μ, and 1.87 μ appear V-shaped on low dispersion spectra, and the maxima near 1.25 μ, 1.6 μ, and 2.1 μ appear broad and rounded. For Omicron Ceti the maxima were found to be pointed instead, like inverted V's; while the minima were deep, broad, and U-shaped. The spectra of Omicron Ceti were made with the 82-inch telescope of the McDonald Observatory on January 15, 1963. The standard stars observed at this time (αOri, βOri, βAnd, αAur, and αBoo) showed no water in their spectra. R.C.M.

N63-15217 Air Force Cambridge Research Labs. Geophysics Research Directorate, Bedford, Mass.
RADIO ASTRONOMY—A SURVEY
A. W. Barber and J. P. Mullen Jan. 1963 35 p 26 refs
(AFCRL-63-224)

The subject of radio astronomy is reviewed from both the historical and instrumentation viewpoints. Problem areas and fruitful areas are noted. Author

06 AUXILIARY SYSTEMS

Includes: fuel cells and solar cells; gas turbines; hydraulic, pneumatic, and electrical control systems and actuators; and inverters.

For primary propulsion systems see: 27 Propulsion

For related information see: 08 Communications; 09 Electronics; 10 Facilities; 15 Instrumentation; and 22 Navigation and Guidance.

N63-14723 Aerojet-General Nucleonics, San Ramon, Calif.
ARMY GAS-COOLED REACTOR SYSTEMS PROGRAM: ANALOG COMPUTER STUDIES OF THE ML-1 POWER PLANT
D. V. Calamore, D. H. Crimmins, and E. Tobey Dec. 1962 15 p
(Contract AT(10-1)-880)
(AGN-TM-400) OTS: $2.50

This report concerns the development and operation of an analog model of the ML-1, the prototype of a mobile nuclear powerplant suitable for military field use. The ML-1 analog model, completed in March 1962, was used for detailed investigation of the operational characteristics of the ML-1. All normal operations and many abnormal operations of the ML-1 can be simulated on this analog model. The components of the plant were described in sufficient mathematical detail so that the model will simulate operations

over the full specified ambient temperature range (-65° to +150° F). The ML-1 simulation was performed by simultaneous use of the Aerojet Differential Analyzer and the Aerojet Network Analyzer (two analog computers at Azusa, California). The reactor for the ML-1 achieved initial criticality in March 1961, and operation of the powerplant was achieved in September 1962. The analog model was used extensively to investigate the behavior of the plant, and as an adjunct to training reactor operators and for testing operational procedures. Author

N63-14724 Atomics International, Canoga Park, Calif.
SNAP AEROSPACE SAFETY PROGRAM Quarterly Technical Progress Report, July-September 1962
L. I. Moss Mar. 20, 1963 57 p
(Contract AT(11-1)-GEN-8)
(NAA-SR-7797) OTS: $1.25

The subject material covers the seven major projects in the SNAP Aerospace Safety Program: Reactor Separation and Fuel Element Ejection, Reactor Transient and Excursion Tests, Reactor End-of-Life Shutdown Devices, Fission Product Release Studies, Critical Configuration Tests, Mechanical and Thermochemical Effects, and Fuel Element Burnup and Fission Products Dispersal. Major emphasis for the period was concentrated on the design of the SNAPTRAN 2/10A-1 and -2 machines and the models for the Reentry Flight Demonstration (RFD-1). Planning of the SNAPTRAN experimental program was undertaken. Analytical effort was concentrated on developing the several computer codes required for interpreting and understanding the data acquired or to be acquired from the experiments. The majority of the Phase I Mechanical and Thermochemical Effects Test Program, conducted at Holloman AFB, was completed. A few fission product releases were conducted at the NRTS. Necessary test apparatus for the water immersion critical experiment was designed and fabricated. Author

N63-14744 Thermo Electron Engineering Corp., Waltham, Mass.
NUCLEAR THERMIONIC SPACE POWER SYSTEMS
R. C. Howard and N. S. Rasor [1963] 69 p 46 refs Presented at the 18th Annual Propulsion Meeting of the Inst. for Aerospace Sciences, Cleveland, Ohio, Mar. 7-8, 1963

The potential and problems of nuclear thermionic reactor systems for space reactor powerplants are discussed. The various thermionic concepts are described and evaluated. The in-core system is discussed both from hardware and from research points of view. A summary of work being conducted is given. D.E.R.

N63-14746 Atomics International, Canoga Park, Calif.
LARGE SPACE RADIATORS
R. Stone (AiResearch Mfg. Co.) and M. G. Coombs [1963] 37 p 17 refs Presented at the 18th Annual Propulsion Meeting of the Inst. for Aerospace Sciences, Cleveland, Ohio, Mar. 7-8, 1963

Aspects of radiator design pertaining to the field of electrical propulsion are discussed. Parametric data on radiators ranging from 100 kwe to 10 Mwe for selected cycles are given. A conceptual design of a radiator for a Mwe system is presented, which indicates an approach to packaging and mechanical design problems. Current radiator designs of the SNAP 2 and SPUR nuclear power systems are reviewed. A.R.B.

N63-14841 Ampex Corp., Redwood City, Calif.
SURVEY OF TAPE REELING SYSTEMS
Art Young Feb. 1963 5 p
(TB-63-2)

This bulletin is the result of a survey of tape reeling systems. For the sake of completeness, some data on related techniques of tape handling in loops and bins, and some techniques employed by the paper industry are included. The ratings of good, medium, and poor, used in comparing the performance characteristics of these systems, are only approximate, since performance of the systems is affected by such factors as component selection, environment, and interrelation with other subsystems. Author

N63-15030 General Electric Co. Missile and Space Vehicle Dept., Philadelphia, Pa.
HYDROGEN-OXYGEN PRIMARY EXTRATERRESTRIAL (HOPE) FUEL CELL PROGRAM, PHASE I Final Report [Apr. 1961-June 1962]
D. W. Puffer (GE. Direct Energy Conversion Operation), F. W. Crimp, Jr., et al Wright-Patterson AFB, Ohio. Flight Accessories Lab., June 1962 625 p
(Contract AF 33(616)-8159)
(ASD-TDR-62-522)

Phase I of this program resulted in the development and environmental test of a 25-watt fuel-cell module, and the design and fabrication of HOPE spacecraft compatible with the improved Blue Scout Booster. The HOPE system has been designed to provide operating capability in orbit for seven days at 50 watts. Two 35-cell, 25-watt/28-volt fuel-cell modules will be provided. A series of development tests were conducted on 6-cell stacks to verify design and life adequacy. Water removal by wicks was developed, tested, and demonstrated. The first flight configuration 35-cell, 25-watt module was utilized in the fuel cell-radiator thermal-vacuum test; although the fuel cell failed after 16 hours of below-par operation, the prime test objective was met in that the thermal design was verified. The second 35-cell, 25-watt module was successfully run at design load for seven days in a thermal simulation chamber. Author

N63-15123 Radio Corp. of America. RCA Labs., Princeton, N.J.
RADIATION DAMAGE TO SOLAR CELLS
J. A. Baicker and P. Rappaport *In* Atomic Energy Commission. Div. of Tech. Inform., Wash., D.C. Protection Against Radiation Hazards in space Proc. of the Symp. at Gatlinburg, Tenn., Nov. 5-7, 1962 p 118-135 9 refs (See N63-15114 11-28) OTS: $7.00
(Paper B-1)

The construction, operation, and performance characteristics of solar cells are described. The radiation-damage process is discussed, and details of proton and electron damage to silicon cells presented. The degradation of the photovoltaic current-voltage characteristics and the spectral response is shown, and a comparison made of various types of solar cells, including silicon, gallium arsenide, and cadmium sulfide. Differences between p/n and n/p silicon cells are discussed and explained in terms of basic properties of the radiation defects. Author

N63-15128 Republic Aviation Corp., Farmingdale, N.Y.
SOLAR CELL DEGRADATION BY PROTONS IN SPACE
Richard Madey *In* Atomic Energy Commission. Div. of Tech. Inform., Wash., D.C. Protection Against Radiation Hazards in Space Proc. of the Symp. at Gatlinburg, Tenn., Nov. 5-7, 1962 p 243-259 5 refs (See N63-15114 11-28) OTS: $7.00
(Paper B-6)

An analytic expression for the decrease in efficiency of a solar cell, behind a protective cover glass, exposed to a spectral distribution of protons is formulated on the basis that the time rate of decrease in output power is proportional to the proton dose rate absorbed at the surface of the solar cell. The decrease in the maximum power output of an n-on-p silicon solar cell exposed to the solar flare of 12 November 1960 is calculated as a function of the thickness of protective cover glass for a power-law representation of the differential flux spectrum of the incident protons. Author

N63-15187 General Electric Co. Spacecraft Dept., Philadelphia, Pa.
HYDROGEN-OXYGEN PRIMARY EXTRATERRESTRIAL (HOPE) FUEL CELL PROGRAM PHASE 1a Final Report [June 1962-Oct. 1962]

L. E. Chapman (GE. Direct Energy Conversion Operation), A. Frank et al. Wright-Patterson AFB, Ohio, Flight Accessories Lab., Jan. 1963 549 p
(Contract AF 33(657)-8960)

The activities conducted on the HOPE (hydrogen-oxygen primary extraterrestrial fuel system) Phase 1a program are described. Included are: research on electrochemical reactions, hydrogen ion diffusion through polymeric membranes, internal mass transport of water through capillary action, and mass transport of water vapor through an ambient of diatomic oxygen gas at 1 atm. pressure. Project HOPE's ultimate objective was the design of a 500-watt fuel-cell power-system, including cryogenic fuel supply, for orbital applications. D.E.R.

N63-15188 General Electric Co. Missile and Space Vehicle Dept., Philadelphia, Pa.
HYDROGEN-OXYGEN PRIMARY EXTRATERRESTRIAL (HOPE) FUEL CELL PROGRAM. PHASE I. APPENDICES Final Report
Wright-Patterson AFB, Ohio, Flight Accessories Lab., June 1962 68 p
(Contract AF 33(616)-8155)
(ASD-TDR-62-522, Append.)

Phase I of this program resulted in the development and test of a 35-cell 25-watt/28-volt space configuration fuel-cell module. The HOPE spacecraft, fuel supply tanks, pneumatics, and thermal systems have been designed and fabricated to provide operating capability in orbit for 7 days at 50 watts, compatible with the Blue Scout launch vehicle. A series of development tests were conducted to verify water removal, thermal design, and 30-day shelf-life of the fuel cell. The 35-cell module was subjected to a series of performance tests. During the last test, it performed continuously for 7 days at an average 27 watts/29.5 volts. Following this test, the module delivered rated power without interruption during vibration tests simulating Blue Scout booster environment. Author

N63-15237 National Aeronautics and Space Administration, Washington, D.C.
HYDRAULIC DESIGN OF AIR COOLING SYSTEMS FOR MULTI-STAGE GAS TURBINES BY USING ELECTRIC MODELS (GIDRAVLICHESKIY RASCHET SISTEM VOZDUSHNOGO OKHLAZHDENIYA MNOGOSTUPENCHATYKH GAZOVYKH TURBIN PRI POMOSCHI ELEKTRICHESKIKH MODELEY)
I. T. Shvets, Ye. P. Dyban, and V. N. Klimenko Apr. 1963 15 p 10 refs Transl. by Faraday Translations from Teploenerg. (Moscow), no. 9, Sept. 1960 p 14-17
(NASA TT F-78) OTS: $0.50

By use of the described model, the time required to compute the design of a cooling system of a two-stage gas-turbine rotor was reduced 10- to 12-fold, and the labor involved in determining the rates of flow of air through elements of the cooling system of a four-stage rotor was reduced to about 1/20 to 1/25. Author

07 CHEMISTRY

Includes: chemical analysis and identification (e.g., spectroscopy); chemical engineering; chemical properties of materials; and synthesis.

For related information see: 18 Materials, Metallic; 19 Materials, Non-metallic; and 26 Propellants and Combustion.

N63-14720 Atlantic Research Corp., Alexandria, Va.
STUDY OF REACTIONS BETWEEN PLASTIC COMPOSITE MATERIALS AND PROPELLANT EXHAUST PRODUCTS Second Quarterly Progress Report, Sept. 1-Dec. 1, 1962
James D. Batchelor, J. Simmons, and W. West Jan. 1963 78 p 5 refs
(Contract AF 33(657)-8475)

Two sets of calculations are used to define the systems in which deleterious chemical reactions are most likely to occur and where experimental testing is most needed. First, the equilibrium compositions of the combustion gases from typical solid propellants are calculated. Second, the equilibrium reactions of each of the more important gases with the refractory materials at 1700° K and above are calculated. D.E.R.

N63-14741 Aeronutronic, Newport Beach, Calif.
INFRARED TRANSMISSION STUDIES. VOLUME III: THE INFRARED ABSORPTION OF CARBON DIOXIDE Final Report
V. R. Stull, P. J. Wyatt, and G. N. Plass Jan. 31, 1963 410 p 23 refs
(Contract AF 04(695)-96)
(SSD-TDR-62-127, Vol. III)

The infrared absorption of carbon dioxide has been calculated over a wide range of path length, pressure, and temperature from 500 to 10,000 cm^{-1}. The results are presented in extensive tables which give the transmission over intervals of 5 cm^{-1} and also averaged over larger intervals. The calculated data representing the intensity, position, and number of spectral lines in a given frequency interval are tabulated in a form which is useful for further transmission calculations. All lines from all isotopic species having an intensity greater than 10^{-8} of the strongest line in an absorption region were included in the calculation. The transmission values were calculated from the quasi-random model which simulates the actual frequency and intensity distributions of spectral lines better than previous models. Author

N63-14813 Oak Ridge National Lab., Tenn.
THE EFFECT OF HIGH ALPHA RADIATION ON THE CORROSION OF METALS EXPOSED TO CHLORIDE SOLUTIONS
R. D. Baybarz Apr. 10, 1962 9 p 2 refs
(Contract W-7405-eng-26)
(ORNL-3265) OTS: $0.50

No direct effects of alpha radiation at a level of 2 watts/liter on corrosion of several alloys and glass were found. Secondary effects were noted for Hastelloys B and C and titanium 45A, these effects being attributed to the presence of H_2O_2 produced by radiolysis of water. Under some conditions, the corrosion rates of Hastelloys B and C were increased and those of titanium drastically decreased by the alpha radiation. Corrosion rates of glass and tantalum were <1 mpy, under all conditions tested, and of Zircaloy-2, <10 mpy. Author

N63-14814 Feltman Research Labs., Picatinny Arsenal, Dover, N.J.
THE HEAT OF FORMATION OF TRISETHYLENEDIAMINE COBALT III PERCHLORATE (TEDCP)
Charles Lenchitz, Rodolf Velicky, and Benjamin Haywood Dec. 1962 17 p 4 refs
(PA-TM-1113)

The heat of formation (ΔH_f) of Trisethylenediamine Cobalt III Perchlorate (TEDCP) was calculated from the reaction:

$$2\left[Co(NH_2(CH_2)_2NH_2)_3\right](ClO_4)_3 + 3Na_2S \rightarrow$$
$$Co_2S_3 + 6NaClO_4 + 6(CH_2NH_2)_2$$

and a value of -196 kcal/mole was obtained. The heat evolved from the above reaction was determined in a differential calorimeter. Author

N63-14860 West Virginia U., Morgantown
PREPARATION OF WOOD-PLASTIC COMBINATIONS USING GAMMA RADIATION TO INDUCE POLYMERIZATION; EFFECTS OF GAMMA RADIATION ON WOOD Annual Report, November 1, 1961 to October 31, 1962

James A. Kent, Anthony Winston, and William R. Boyle Mar. 1, 1963 54 p 9 refs
(Contract AT-(40-1)-2945)
(ORO-600) OTS: $1.25

Investigations of wood-plastic combinations are being conducted in the following areas: (1) physical testing of wood-polymer combinations; (2) impregnation of wood with monomers; (3) chemical analysis of the operations, including polymerization rates, gamma dose rate dependence, and effects of additives; and (4) the effects of gamma radiation on the physical properties of wood. Wood-polymer combinations, based on white pine, birch, and white oak, exhibited increased proportional limits in compression and hardness over values for the base wood. A method for determining polymer distribution in wood, based on the density of small samples, was developed, and the rapid sectioning and weighing of monomer-impregnated specimens was used to determine the extent of penetration. Tests of irradiated wood showed that nitrogen penetratibility is slightly decreased and that the proportional limit to compression is also decreased. M.P.G.

N63-14875 Midwest Research Inst., Kansas City, Mo.
SYNTHESIS OF ELASTOMERS CONTAINING Si-N BONDS IN THE MAIN CHAIN Quarterly Progress Report No. 6, 1 Jan.-31 Mar. 1963
L. W. Breed and R. L. Elliott Apr. 15, 1963 27 p 5 refs
(Contract DA-23-072-ORD-1687)

Improvement in the hydrolytic stability of polymers prepared by the condensation of silazanes with organic diols is observed when N-H groups in the polymer chain are replaced by N-methyl groups. Several new diols have been examined in this type of polymerization, but none of the materials equal resorcinol, 1,4-benzenedimethanol, 4,4'-dihydroxybiphenyl, or bisphenol "A". In studies of the reactions of cyclic silicon-nitrogen compounds under the influence of acidic or basic catalysts at 175° C, it was concluded that the chief reaction involves randomization of the cyclic structure. A new polymer containing phenylene groups and silicon and nitrogen in the main chain is reported. Author

N63-14879 Brussels U. (Belgium)
VAPORIZATION OF COMPOUNDS AND ALLOYS AT HIGH TEMPERATURE. PART VII. THERMODYNAMIC STUDY OF TIN AND LEAD SULFIDE USING A MASS SPECTROMETER [Final Report, Mar. 1961-Mar. 1962]
Reginald Colin and John Drowart Wright-Patterson AFB, Ohio, Directorate of Materials and Processes, Apr. 1962 25 p 50 refs
(Contract AF 61(052)-225)
(WADD-TR-60-782, PT. VII)

Reaction enthalpies, $\Delta H°_{298}$, in kcal/mole, determined were $SnS(s) \rightarrow SnS(g)$: 52.6 ± 1.6 kcal/mole; $2\ SnS(s) \rightarrow Sn_2S_2(g)$: 56.5 ± 5.0; $PbS(s) \rightarrow PbS(g)$: 55.7 ± 1.6; $2\ PbS(s) \rightarrow Pb_2S_2(g)$: 66.6 ± 5.0; $SnPbS_2(g) \rightarrow SnS(g) + PbS(g)$: 46.5 ± 5.0; $PbS(g) \rightarrow Pb(g) + \frac{1}{2} S_2(g)$: 28.8 ± 2.6. Author

N63-14880 Brussels U. (Belgium)
VAPORIZATION OF COMPOUNDS AND ALLOYS AT HIGH TEMPERATURE Annual Summary Report No. 3, 1 Mar.-28 Feb. 1962
P. Goldfinger et al [1962] 32 p
(Contract AF 61(052)-225)

High-temperature mass spectrometric studies were reviewed. Subjects covered were: correlations of dissociation energies and heats of vaporization; mass spectrometric study of gaseous species in the systems boron-carbon and boron-carbon-silicon; mass spectrometric determination of the sublimation of boron and of the dissociation energy of B_2; the determination of relative ionization cross sections for Zn, Se, and Se_2, and the measurement of the dissociation energy of the molecule Se_2; mass spectrometric study of the evaporation of alkaline earth sulfides and of indium sulfide; and vaporization of strontium oxide. A.R.B.

N63-14893 Baylor U., Waco, Tex.
THE EFFECT OF ADDITIVES ON ELECTRODEPOSITION AND ELECTRODISSOLUTION OF METALS [Final Report]
Thomas C. Franklin, Jerry Barrett, Robert E. Graves, Fred Tibbals, and John Bowman Wright-Patterson AFB, Ohio, Directorate of Materials and Processes, Mar. 1963 49 p 147 refs
(Contract AF 33(657)-7485)
(ASD-TDR-63-212)

A preliminary investigation was made of the effect of additives on the electrodeposition of cadmium and on the electrodissolution of nickel. The electrodeposition study was primarily limited to a study of techniques. These techniques included constant current pulses, cyclic voltammetry, microvolumetric measurement of hydrogen evolved, and hydrogen embrittlement. It was found that the current efficiency for the deposition of cadmium varied with concentration of additive in a regular pattern. Using different plating times, different base metals, different current densities, and in stirred and unstirred solutions, the additive effects on current efficiency were similar. The electrodissolution study indicated that under some conditions an oxidizing additive acted on the metal in a first-order corrosion reaction. This reaction was accelerated by the application of the anodic potential. Author

N63-14899 Air Products and Chemicals, Inc. Research and Development Dept., Allentown, Pa.
JOULE-THOMSON NEON LIQUEFIER
Abraham Lapin [1963] 15 p 6 refs Presented at the ASHRAE Semiannual Meeting, N. Y., Feb. 11-14, 1963 Submitted for Publication
(NASA Contract NASr-107)
OTS: $1.60 ph, $0.80 mf

The merits of hydrogen, helium, deuterium, and neon as suitable refrigerants in a neon liquefier were compared by using the Joule-Thomson effect. It was shown that the most advantageous refrigerant in a Joule-Thomson refrigerator is neon itself. Deuterium can be eliminated because of its unavailability. A.R.B.

N63-14923 American Cyanamid Co., Stamford, Conn.
BIBLIOGRAPHY OF VACUUM ULTRAVIOLET SPECTROSCOPY [Final Report, July 1960-Oct. 1962]
Robert C. Hirt and Richard G. Schmitt Wright-Patterson AFB, Ohio, Directorate of Materials and Processes, Feb. 1963 49 p 1328 refs
(Contract AF 33(616)-7958)
(ASD-TDR-62-915)

The bibliography is arranged alphabetically by senior author, with a four-letter code (called CODEN) for the journal reference. The format and presentation are suited for easy punching onto IBM punched cards for machine sorting. A subject index is provided to the more than 1300 references. Author

N63-14941 General Electric Co. Research Lab., Schenectady, N.Y.
THE DECOMPOSITION OF ETHYLENE AND ETHANE IN PREMIXED HYDROCARBON-OXYGEN-HYDROGEN FLAMES
C. P. Fenimore and G. W. Jones Schenectady, N.Y., The Knolls, Res. Inform. Section, Apr. 1962 21 p 21 refs
(Rept. 62-RL-(2988-C))

The experimental procedures used previously to study the breakup of CH_4 in flames are applied to C_2H_4 and C_2H_6. Composition and temperature profiles are obtained by probing low pressure, flat flames; the profiles are recast as reaction rates. In ethylene flames, the consumption of hydrocarbon is found to be due mostly to an attack by O atoms. $k'' \sim 3 \times 10^{10}$ l mole^{-1} sec^{-1} at 1400 to 1860° K with little temperature dependence, in fair agreement with recent estimates at much lower temperatures. In the presence of much added H_2, transient CH_4 appears in the reaction zone in amounts which are quantitatively consistent with a formation of CH_3 radicals. In ethane flames, an initial attack by O atoms

is not important. For H + C_2H_6, k ~ 1.4 × 10^{11} exp(−9.7 kcal/RT) 1 $mole^{-1}$ sec^{-1} in fair agreement with most estimates at lower temperatures, the activation energy being thought reliable to about ± 2 kcal. Author

N63-14944 Rensselaer Polytechnic Inst. Interdisciplinary Materials Research Center, Troy, N.Y.

SEMI-ANNUAL PROGRESS REPORT NO. 4 SEPTEMBER 1, 1962 TO FEBRUARY 28, 1963

D. Hansen et al. Mar. 27, 1963 17 p

(NASA Grant NsG-100-60)

OTS: $1.60 ph, $0.80 mf

Materials research is reported for the following areas: metallurgy, chemical engineering, ceramics, and electrical engineering. The research projects in these areas include: polymer research, nucleation in liquid metals, ultrasonic research, diffraction studies, high-temperature alloys, low-temperature physics, dispersion-strengthened materials, corrosion studies, and nuclear magnetic resonance research. R.C.M.

N63-14980 Reaction Motors Div., Thiokol Chemical Corp., Denville, N.J.

ROCKET EXHAUST SAMPLING SYSTEM FOR TWO PHASE EXHAUST FLOW SYSTEMS Final Report

J. I. Schaeffer [1961] 34 p

(Contract AF 04(611)-6351)

(RMD-2103-F)

A rocket-engine, two-phase, exhaust sampling system has proved feasible for collecting a representative exhaust sample, during the steady state portion of engine operation, that can be used to determine the exhaust solids-to-gas ratio and solid particle size. Since particle concentration apparently tends to be highest along the centerline of the exhaust stream, a particle distribution profile should be obtained by sampling the exhaust at several points in the exhaust plume cross section in order to get a representative solids-to-gas ratio at a given operation condition. In order to obtain a two-phase flow exhaust sample in the proper ratio, a bow shock at the probe entrance is not permissible. A bow shock will not form provided that the backpressure does not exceed 70% of the stagnation pressure during the sampling cycle. A.R.B.

N63-15110 Eidgenössische Technische Hochschule, Zurich (Switzerland)

ISOMORPHIE- UND MORPHOTROPIE-BEZIEHUNGEN BEI OXYDEN MIT TiO_2-TYP UND VERWANDTEN STRUKTUREN [ISOMORPHIC AND MORPHOTROPIC RELATIONSHIPS IN OXIDES OF THE TiO_2-TYPE AND SIMILAR STRUCTURES]

Gerhard Bayer (Ph.D. Thesis) Zurich, Schmidberger and Müller, 1962 70 p 62 refs In German

(*Its* Prom 3240)

Investigations of the existence of oxidizable phases of anatase and brookite rutiles, as well as their "superstructures" trirutile and columbite, resulted in the discovery of many new combinations and an increase in the understanding of polymorphic and morphotropic miscibility. Results of spectral analyses of the oxides are as follows: (1) The infra spectra of three TiO_2 modifications show differences. Rutile type combination AO_2, ABO_4 and mixed crystals $AB_2O_6.TiO_2$ have, in general, two wide absorption bands in 10μ-22μ region. (2) The band intensity increases most with increased deformation of the $[AO_6]$ and $[BO_6]$ octahedron, from $TiO_2 \rightarrow TeO_2$. $ATa_2O_6 \rightarrow ASb_2O_6$, respectively. Separations of the bands occur frequently. (3) An increase in the masses of the A and B ions usually results in a shifting of the absorption bands to a longer wavelength. (4) Band sharpness and scattering decrease, in general, with an increase in the number of different cations in the rutile structure. (5) An ordered distribution of cations, in the trirutile structure, results in sharper absorption bands. (6) The number and sharpness of the absorption bands increase in the cases of ABO_4 and AB_2O_6 combinations due to an increased difference ($\Delta = r_A - r_B$) of the ionic radii. For example: $AlSbO_4$ (Δ = 0.11) and $ZnTa_2O_6$ (Δ = 0.06) have sharper defined absorption bands than the other $ASbO_4$ and ATa_2O_6 combinations (Δ = 0.01 to 0.04). (7) In general, the number of bands is larger when the difference in valences of A and B increases from two (for ABO_4) to three for (trirutile combinations). This could be the result of a strong deformation of the oxygen octahedron. (8) The majority of rutile type compositions which contain transition elements, such as Fe, CO, Ni, Ta, in their lattices show few sharp bands. I.v.L.

N63-15160 Temple U. Research Inst., Philadelphia, Pa.

ADDITION AND SUBSTITUTION PRODUCTS OF OXYGEN FLUORIDES Third Annual Progress Report [Jan. 1-Dec. 31, 1962]

A. G. Streng, A. D. Kirshenbaum and A. V. Grosse Jan. 15, 1963 68 p 34 refs

(Contract Nonr-3085(01))

Chemical reactions of oxygen fluorides were studied to obtain addition products of high oxidizing power. The chemical characterization of dioxygen difluoride is given, and the reactions of formation of the intermediate compounds O_2ClF_3, O_2BrF_5, and O_2SF_6, as well as some others, are described. A new method, which uses electric discharge, of preparing xenon tetrafluoride, XeF_4, is given. The preparation of xenon oxyfluorides is described. Using the same method, at liquid air temperatures, it was possible to synthesize the first compound of krypton, i.e., krypton tetrafluoride or KrF_4. It forms colorless transparent crystals, more volatile and less thermally stable than XeF_4. Author

N63-15174 Shell Development Co., Emeryville, Calif.

FUNDAMENTAL RESEARCH ON ADVANCED OXIDIZERS Quarterly Technical Report No. 1, Dec. 1962-Feb. 1963

D. W. Barnum, R. M. Curtis, F. S. Mortimer, and J. N. Wilson [1963] 50 p 124 refs

(Contract DA-31-124-ARO(D)-54; ARPA Order 402)

(S-13876)

Thermochemical data have been compiled and are discussed as follows: heats of formation, ionization potentials and available electron affinites of simple compounds and radicals made up of the elements Cl, F, O, N, H, and C. Some of these data are assembled into tables in this report. Other areas covered include: (1) a survey of available structural data; (2) a study of the additivity of bond energies in the mixed fluorochloromethanes; the deviations from additivity in the fluoromethanes are found to be greater by an order of magnitude than those in the chloromethanes; (3) a computer program for calculating the Madelung energy of ionic crystals by Evjen's method; and (4) a study of analogies in the heats of formation of the hydrides and fluorides of nitrogen and their positive ions. Author

N63-15203 Cornell U. Graduate School of Aerospace Engineering, Ithaca, N.Y.

ABSORPTION SPECTRA OF POLYATOMIC MOLECULES AT HIGH TEMPERATURES. II: BENZENE AND PERFLUOROBENZENE. KINETICS OF THE PYROLYSIS OF BENZENE Technical Report

S. H. Bauer and C. F. Aten, Jr. Dec. 1962 40 p 16 refs

(NASA Grant NsG-116-61)

(CU-7470) OTS: $3.60 ph, $1.40 mf

The near-ultraviolet absorption spectra of benzene and of hexafluorobenzene vapors were measured at high temperatures over the range 690° K to 1900° K. The samples were diluted with

argon (90% to 99% of inert gas) and shock heated. Absorption coefficients were evaluated at a fixed frequency (Hg, λ2537) as a function of time after passage of the shock front [$I_\lambda(t)$], and as a function of wavelength at a fixed time interval [$I_t(\lambda)$]. For temperatures below 1300° K for C_6H_6 and 1600° K for C_6F_6, absorptions were recorded prior to the occurance of significant decomposition of the sample; above these temperatures, values were deduced from measurements extrapolated to zero time. A mechanism for the pyrolysis of benzene is proposed which is compatible with flow experiments through tubes at 1500° K and with the present shock tube data. Author

N63-15226 Technische Hochschule in Graz. Inst. für Physikalische Chemie (Austria)

STUDIES OF PREPARATION AND PROPERTIES OF ACTIVE ALKALI AZIDES AND EFFECTS OF THIS ACTIVITY ON THERMODYNAMIC AND THERMOCHEMICAL DATA Monthly Technical Status Report No. 16, Dec. 1-31, 1962

Karl Torkar Jan. 9, 1963 9 p

(Contract DA-91-591-EUC-1713)

"Black" sodium azide was prepared from commercial sodium azide and was analyzed for cationic impurities, for heavy metals, and for methanol. D.E.R.

08 COMMUNICATIONS

Includes: communications equipment and techniques; noise; radio and communications blackout; telemetry; tracking; and wave propagation.

For tracking stations see: 10 Facilities.

For related information see: 06 Auxiliary Systems; 09 Electronics; 15 Instrumentation; and 22 Navigation and Guidance.

N63-14734 Electronic Communications, Inc. Research Div., Timonium, Md.

MILLIMETER WAVE COMPONENT RESEARCH Final Report

F. Sobel, F. L. Wentworth, M. Cohn, and J. C. Wiltse Mar. 1962 74 p 18 refs

(Contract AF 19(604)-5475)

(AFCRL-62-174)

Recent work conducted is reported and work which was described earlier in Scientific Reports Nos. 1, 2, and 3 is summarized. Components and techniques for the generation, transmission, and detection of energy in the 100 to 300 Gc frequency region were investigated theoretically and experimentally. Author

N63-14770 Rome Air Development Center. Control Systems Lab., Griffiss AFB, N.Y.

A LOW FREQUENCY HOMING BEACON TRANSMITTER FOR PROJECT JUNGLE JIM

Herbert C. Thorpe and Lodgrick B. Rivers Feb. 1963 23 p

(RAL-TM-63-1)

The Low Frequency Homing Beacon Transmitter was fabricated in-house in the Control and Guidance Laboratory of Rome Air Development Center, Griffiss Air Force Base, New York, for installation in the AN/MRN-15 Air Traffic Control Set. The beacon set operates in the LF range from 200 kcs to 400 kcs at a power output of 100 watts, and is capable of keyed CW(A1) and voice (A3) modes of transmission. The equipment operates from a nominal 117 v, 60-cps power source with a 5-ampere consumption. Author

N63-14798 National Research Council of Canada. Radio and Electrical Engineering Div., Ottawa

THE PERFORMANCE OF NRC TELEMETRY COMPONENTS IN BLACK BRANT III DYNAMIC FIRINGS 05 AND 06

F. V. Cairns, J. H. Craven, and J. K. Pulfer Jan. 1963 7 p Supplement to Report ERB-619 (See N63-10462 01-08)

(ERB-626; Suppl. to ERB-619)

Since the report (ERB-619) on the performance of NRC telemetry components in the first Black Brant III dynamic firings was issued, two further firings of this series have taken place. Additional results from these two firings are discussed in the present report. Author

N63-14850 Polytechnic Inst. of Brooklyn. Microwave Research Inst., N.Y.

COUPLED LINE FILTERS Research Report

Nobuji Saito Dec. 13, 1962 136 p 52 refs Transl. by Akio Matsumoto

(Contract AF 30(602)-2213)

(PIBMRI-1048-62; RADC-TDR-63-40)

This paper describes the method of designing distributed networks consisting chiefly of distributed coupled lines. Coaxial filters are the representative ones of distributed filters. They are of practical use because of their simplicity of construction and design procedures. On the other hand, it is sometimes difficult to obtain those of desired characters, owing to many restrictions. Coupled line filters came into use to supplement these drawbacks and displayed their merits as narrow-band filters. As they grew familiar, varieties of networks were found, and have now significant uses in microwave bands as strip-line filters. Author

N63-14853 National Bureau of Standards, Boulder, Colo.

QUARTERLY RADIO NOISE DATA, JUNE, JULY, AUGUST 1962

W. Q. Chrichlow, R. T. Disney, and M. A. Jenkins Mar. 1, 1963 80 p 11 refs

(NBS-TN-18-15) GPO: $0.45

Radio noise measurements are presented from the worldwide network of sixteen monitoring stations. The data are given in tabular form on the basis of the mean power, the mean envelope voltage, and the mean logarithm of the envelope voltage. R.C.M.

N63-14858 Lockheed Missiles and Space Co., Sunnyvale, Calif.

SATELLITE-TO-SATELLITE PROPAGATION EXPERIMENT FEASIBILITY STUDY AND PRELIMINARY DESIGN Scientific Report No. 1

John D. Meyer Bedford, Mass., AFCRL. Electronics Research Dir., Dec. 11, 1962 71 p 4 refs

(Contract AF 19(628)-457)

(AFCRL-63-4)

The effects of the ionosphere upon radiofrequency electromagnetic waves are discussed. Several types of satellite-to-satellite propagation experiments are presented, and the problems of implementation are delineated. The equipment around which the experiment must be designed is described, as are the vehicles available in Program 162. The relative merits of the various vehicles and the basis for the selection of the experimental configuration are discussed. The preliminary design results are shown. Author

N63-14953 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

X-BAND TELEMETRY SYSTEMS FOR REENTRY RESEARCH

E. A. Brummer [1963] 19 p 6 refs Presented at the Inst. of Elec. and Electronics Engrs., Region 3 Meeting, Richmond, Va., Apr. 24–26, 1963

(Conf. Paper CP-63-663)

This paper describes an X-band telemetry system which offers a solution to the "radio-blackout" problem for earth-orbit reentry

velocities. The application of this system for avoiding blackout and for making diagnostic measurements of the blackout-inducing plasma layer in Project RAM, a reentry-communication research investigation being conducted by the NASA Langley Research Center, is discussed. Author

N63-14955 Stanford Research Inst., Menlo Park, Calif.
DESIGN APPROACHES FOR SATELLITE ANTENNAS Final Report, Task I
J. A. Martin Feb. 1962 174 p 108 refs
(Contract AF 04(647)-483)

This report is concerned with antennas for active earth satellite communication relays. Both earth-satellite and satellite-satellite communication links, as well as both instantaneous and delayed retransmission, are considered. The satellite orbits considered are assumed to be circular or near circular; special emphasis is placed on circular orbits at altitudes of 100, 1000, 5000, and 19,400 nautical miles. A major part of the report is devoted to describing in some detail the many system considerations, such as system functions, satellite-earth geometry, antenna pattern coverage, and environment, from which the antenna requirements are derived. A second major part deals with basic antenna parameters that are involved in selecting, evaluating, or developing satellite antennas. Data and curves show effects of trade-offs between electrical characteristics or between electrical and physical characteristics. Some antennas being developed for current satellites are described; and some areas needing further research are pointed out. Author

N63-14967 National Bureau of Standards, Boulder, Colo.
THE ERROR RATES IN MULTIPLE FSK SYSTEMS AND THE SIGNAL-TO-NOISE CHARACTERISTICS OF FM AND PCM-TS SYSTEMS
Hiroshi Akima Mar. 25, 1963 60 p 35 refs
(NBS-TN-167) GPO: $0.40

The element and symbol error rates in multiple FSK (frequency-shift-keying) systems and the output SNR (signal-to-noise ratio) in FM (frequency-modulation) and PCM-FS (pulse-code-modulation-frequency-shift) systems are evaluated for wide ranges of system parameters, assuming that the incoming signal and noise in the demodulator are a fading-free signal and an additive white Gaussian noise, respectively. It is shown that the required intrinsic SNR for an assigned value of symbol error rate in multiple FSK systems can be reduced by increasing the number of frequencies in the keying. The possibility of improving the threshold of FM systems beyond that of conventional ones by modulating the carrier with sampled values and demodulating the modulated wave with a band-dividing demodulator is shown. The value of the intrinsic SNR at the threshold increases with the value of modulation index in band-dividing FM systems, and with the number of quantizing levels in PCM-FS systems when the base in the coding or the number of digits for each sample is kept constant. The maximum output SNR in PCM-FS systems depends only on the number of quantizing levels and not on the base, whereas the threshold decreases as the base increases. From the comparison of the threshold in band-dividing FM systems with that in PCM-FS systems, it is shown that the latter cannot be lower than the former but can only approach the former when the base approaches the number of quantizing levels. Brief discussions on the threshold effects in frequency-lock and phase-lock FM demodulators suggest that the threshold of these feedback FM demodulators cannot be improved beyond that of a band-dividing one. Author

N63-14995 Naval Research Lab., Washington, D.C.
U. S. NAVY SPACE SURVEILLANCE HIGH-POWER TRANSMITTER—LAKE KICKAPOO STATION
L. D. Breetz Jan. 5, 1962 31 p
(NRL-5717)

A 560-kw transmitting station which fills the central gap in the U.S. Navy Space Surveillance fence was completed and put in operation in June 1961. This report describes the design and installation of this station located in North Central Texas. Two novel features in the design of this station are the use of commercial FM and TV power units and the method by which their power outputs were combined to give a total output of 560 kw. Author

N63-15048 Stanford Research Inst., Menlo Park, Calif.
DETERMINATION OF CONDITIONS FOR MULTIPLE USE OF FREQUENCY ALLOCATIONS FOR SATELLITE COMMUNICATIONS AND GROUND SERVICES Final Report
G. H. Hagn, A. S. Dennis, R. G. Gould, and H. A. Turner Feb. 1963 75 p 11 refs
(NASA Contract NASr-49(02); SRI Proj. 3773)
OTS: $7.60 ph, $2.45 mf

Transmission experiments have been carried out to determine the feasibility of sharing frequency allocations between existing ground services and communication satellite systems. Calculations of the influence of weather on interference between ground-satellite communication and purely terrestrial links are summarized. Also, results of work not previously published are included on: measurements made on point-to-point microwave stations of radiation in the vertical plane; and measurements made to confirm the advantages of using natural-terrain features to shield ground stations. R.C.M.

N63-15061 Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
CODING THEORY AND ITS APPLICATIONS TO COMMUNICATIONS SYSTEMS
Leonard Baumert, Mahlon Easterling, Solomon W. Golomb, and Andrew Viterbi Mar. 31, 1961 91 p 31 refs
(NASA Contract NASw-6)
(JPL-TR-32-67) OTS: $8.60 ph, $2.93 mf

A general theory of binary sequences with desirable correlation properties is developed for application to the design of digital communication systems. The underlying mathematical problems are the existence, construction, and properties of "orthogonal matrices" or, as they are also known, "Hadamard designs." The first detailed application is to the design of a ranging system with unambiguous, high-precision resolution over interplanetary distances which can nonetheless be quickly synchronized and yield its range data in real time. The second major application is to the design and analysis of optimum digital telemetry systems. It is shown that for several categories of codes with suitable orthogonality properties, the theoretical bound on the information rate is actually approached, as the number of code words increases, for specific input signal-to-noise conditions. Author

N63-15062 Technical Research Group, Inc., Syosset, N.Y.
MILLIMETER-WAVE AMPLIFICATION BY RESONANCE SATURATION Technical Note No. 2
Benjamin Senitsky, Gordon Gould, and Sylven Cutler Feb. 13, 1963 30 p 9 refs
(Contract AF 30(602)-2744)
(RADC-TDR-63-84)

The nonlinear properties of a power-saturated resonant medium are used to obtain amplification of millimeter-wave radiation. Experiments demonstrating this effect are performed with the 3.5-mm rotational resonance of hydrogen cyanide ($HC^{12}N^{15}$) gas. An incoming radiation spectrum consisting of a strong saturating component at 3.5-mm and weak sidebands is transmitted through a gas-filled, 3/4-inch-diameter, 20-ft., circular waveguide operated in the TE_{01} mode. Under certain conditions, power can be transferred from the strong saturating component to the weak sidebands. A sideband gain with a maximum value of 1.5 db is measured when the sidebands are phased for amplitude modulation

and the saturating component input power is 4.8 mw. The bandwidth for this type of amplification is equal to the power-broadened linewidth. Sidebands phased for frequency modulation are always attenuated. The experimental results are in agreement with computations based on the solution of the quantum mechanical Boltzmann equation. These computations indicate that a single sideband can also be amplified. Author

N63-15098 Ohio State U. Research Foundation. Antenna Lab., Columbus

APPLICATION OF ELECTROMAGNETIC ABSORBING MATERIALS AS INTERFERENCE REDUCTION TECHNIQUES
Interim Engineering Report, 6 Mar. to 5 Sept. 1962
L. Peters, Jr., R. C. Rudduck, and P. M. Russo Griffiss AFB, N.Y., Electronic Warfare Lab., Mar. 1963 16 p 6 refs
(Contract AF 30(602)-2711)
(RADC-TDR-63-7)

The use of radar absorber material is being considered for reduction to radiofrequency interference (RFI). The study of sidelobe reduction is being applied to three antenna types: the paraboloid reflector, the Luneberg lens, and the horn antenna. A method is proposed for the design of a null in the Fresnel zone for the purpose of RFI reduction with a small antenna located in the null. Author

N63-15106 Air Force Cambridge Research Labs. Electronics Research Directorate, Bedford, Mass.

GEOLOGICAL AND GEOPHYSICAL CONSIDERATIONS IN RADIO PROPAGATION THROUGH THE EARTH'S CRUST
Research Note
L. A. Ames, J. W. Frazier, and A. S. Orange Feb. 1963 11 p 24 refs
(AFCRL-63-40)

Geological and geophysical considerations applicable to radio propagation through the rock strata of the basement complex are presented. Information on electrical characteristics of rocks, based on laboratory measurements on samples, is shown to be misleading because *in situ* conditions are very difficult to analyze and reproduce. The complexity of the basement geology adds to the difficulty of predicting *in situ* rock characteristics pertinent to radio propagation. Folding and fracturing of the strata, variegated rock types, and the anisotropy of rock resistivity cause the actual propagation path loss to be vastly different than that predicted on the basis of a simple geological model. This conclusion is supported by the available experimental data. Deep resistivity measurements made from the surface indicate that basement strata will have resistivities of the order of 10^3 to 10^4 ohm-meters over most of the United States. Author

N63-15175 Polytechnic Inst. of Brooklyn. Microwave Research Inst., N.Y.

ERROR CONTROL IN DIGITAL COMMUNICATION
Amfinn Moe Manders Jan. 1963 80 p 13 refs
(Grant AFOSR-62-295)
(PIBMRI-1076-62)

The investigation in this thesis seeks a solution to the problem of obtaining the maximum transmission rate subject to a fixed permissible-error rate and a fixed equipment complexity. The method by which this is accomplished is to use an error-correcting device (ECD) that examines the signal for signs that a burst of impulse noise is likely to have occurred. The bits that are in doubt are erased and replaced by use of a two-dimensional parity check. This method allows a few errors to pass undetected by the ECD and will therefore give a small but definite probability of errors in the presence of noise bursts. Some of these errors can be corrected if the code used has some error-correction capability. Author

N63-15189 Illinois U. Electrical Engineering Research Lab., Urbana

A LOW INSERTION LOSS, CAPACITIVELY SCANNED GONIOMETER FOR FARADAY ROTATION MEASUREMENTS IN THE V.H.F. RANGE
A. B. Gschwendtner and G. W. Swenson, Jr. Feb. 28, 1963 27 p 3 refs
(NASA Grant NsG-24-59)
OTS: $2.60 ph, $1.01 mf

The design and use of a goniometer for determining the direction of rotation of a moon reflected wave are reviewed. The relevant theory dealing with a low insertion loss, capacitively scanned goniometer, for Faraday rotation measurements in the very high frequency range has been derived. In addition, the design criteria and test procedure for such a device in the frequency range 25 mc/s to 60 mc/s has been established. Insertion loss on the order of 2 db has been easily achieved with standard components. Observations have been made on moon reflections at 26.9 mc/s and satellite emissions at 54 mc/s and, in each case, the number of rotations and directions were easily detectable. In addition to its utilization for measurements of lunar echoes, this device shows promise for application with the projected Excentric Orbiting Geophysical Observatory satellite and the study of depolarization during scintillation. I.v.L.

N63-15195 RAND Corp., Santa Monica, Calif.

TRANSIENT SOUND PROPAGATION IN A SIMPLE MODEL OF A TRIPLE-LAYERED MEDIUM
Allan D. Pierce Apr. 1963 89 p 23 refs
(RM-3478)

A theoretical study has been made of the transient sound propagation from a point source in a triple-layered medium consisting of a homogeneous fluid layer sandwiched between two similar half-spaces of the same density but of higher sound speed. The source spectrum is such that a large number of normal modes are excited. Both source and receiver are assumed to be in the same half-space. The general solution consists of a direct wave, a wave reflected from the near edge of the center layer, a lateral wave, and the normal and complex mode waves. At large distances r the normal mode waves dominate. It is found that one may relate frequency, phase velocity, group velocity, and excitation amplitudes parametrically, and, on the basis of this, the variation of the characteristics of the normal modes with mode number n is studied. Similar methods can be used to study the complex modes. Each normal mode is found to carry a limited band of frequencies—the bandwidth for higher order modes being approximately proportional to n^{-1}. Unless r is extremely large, the amptitudes of the Airy phases for the higher order modes will be negligible. On the basis of the study, one may give a qualitative description of the waveforms. One effect of placing source and receiver outside the center layer is to accentuate lower order modes and the lower frequency portion of the source spectrum. Author

09 ELECTRONICS

Includes: circuits and circuit theory; electronic components (e.g., tunnel diodes, transistors, and tubes); and feedback and control theory.

***For related information see:* 06 Auxiliary Systems; 08 Communications; 15 Instrumentation; 22 Navigation and Guidance; and 25 Physics, Solid-State.**

N63-14784 Naval Research Lab., Washington, D.C.

AN ALPHA RHYTHM FEEDBACK CONTROL UNIT
W. D. Dahl. Nov. 21, 1962 22 p 19 refs
(NRL-5848)

It has been hypothesized that if a photic stimulus is applied to a subject at the proper time during each cycle of his alpha rhythm, the alpha rhythm will be reinforced. Electronic analog equipment has been designed and constructed, giving the experimenter the necessary control of the phase of the stimuli. The input signal to this equipment is obtained from the amplifier of any one of the eight channels of the EEG recorder. A 10-microsecond output pulse (adjustable from 0 to 60 volts) triggers a photolamp placed directly in front of the subject's closed eyes. The resultant photic stimulation presumably modifies the alpha rhythm, thereby completing a closed feedback loop. In tests using a simulated alpha-rhythm signal consisting of a sinusoidal waveform, the phase of the output pulse was adjustable to an accuracy of better than 1 percent. The phase jitter was about 0.1 percent. With a more realistic test signal consisting of a sine wave mixed with low-frequency noise (signal-to-noise ratio of about 5), the phase jitter increased to about 1 percent. Author

N63-14851 Directorate of Advanced Systems Planning, Aeronautical Systems Div., Wright-Patterson AFB, Ohio

PROBABILITY THEORY AS APPLIED TO RELIABLE NETWORK DESIGN

James D. La Rue Nov. 1962 55 p 17 refs
(IM-1062)

The probability of success equations for redundant networks are derived from basic component failure statistics. The components have two modes of failure, open or short. The report calculates the equations for four basic redundant networks. A network is then designed, based upon these results. The reliability of this network is calculated and compared to several other designs.
Author

N63-14905 Air Force Systems Command. Foreign Technology Div., Wright-Patterson AFB, Ohio

THE NATURE OF THE LONG SPARK (PRIRODA DLINNOY ISKRY)

I. S. Stekol'nikov and B. M. Vul, ed. Feb. 28, 1962 433 p 204 refs
Transl. from the Russian publ. Moscow, Izdatel'stvo Akad. Nauk SSSR, 1960 p 1–272
(FTD-TT-61-149/1+2)

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N63-14906 Air Force Systems Command. Foreign Technology Div., Wright-Patterson AFB, Ohio

EQUIPMENT AND METHODS OF INVESTIGATION

In its Nature of the Long Spark Feb. 28, 1962 p 31–85 24 refs (See N63-14905 11-09)

Equipment for the investigation of pulse discharges is described and the pulse voltage generator is set up. Optical methods for studying discharges and procedures for obtaining electrical measurements are enumerated; oscillographic and indirect current recording, shunting, and voltage recording data are given. D.E.R.

N63-14907 Air Force Systems Command. Foreign Technology Div., Wright-Patterson AFB, Ohio

PULSE TYPE OF LONG-SPARK CORONA

In its Nature of the Long Spark Feb. 28, 1962 p 86–139 33 refs (See N63-14905 11-09)

Ionization and excitation of neutral gas particles produces a corona, a visually perceivable gas radiance near an electrode in a nonuniform field. The corona produced by an alternating or pulsed current is discussed with regard to its production mechanism, propagation, and properties. D.E.R.

N63-14908 Air Force Systems Command. Foreign Technology Div., Wright-Patterson AFB, Ohio

THE LEADER STAGE OF A LONG SPARK

In its Nature of the Long Spark Feb. 28, 1962 p 140–216 37 refs (See N63-14905 11-09)

The leader channel, second stage of a spark, is examined during formation and development, to a point at which the channel bridges the entire discharge gap. Phenomena observed are discussed and electrical characteristics are given. Also, leader channel in liquids are mentioned. D.E.R.

N63-14909 Air Force Systems Command. Foreign Technology Div., Wright-Patterson AFB, Ohio

MAIN STAGE OF A LONG SPARK

In its Nature of the Long Spark Feb. 28, 1962 p 217–259 12 refs (See N63-14905 11-09)

The main, or third, stage of a spark, characterized by a rapid change of current and light intensity, is examined by wave parameter determination and current simulation. D.E.R.

N63-14910 Air Force Systems Command. Foreign Technology Div., Wright-Patterson AFB, Ohio

FINAL STAGE OF A LONG SPARK

In its Nature of the Long Spark Feb. 28, 1962 p 260–285 15 refs (See N63-14905 11-09)

The transformation of the main stage of a long spark into an arc is the final stage of the spark and has its own special characteristics. A formula for finding the stage's initial current is derived, its longitudinal gradients are determined, the channel diameter and current density are found, and the effects of the final stage on the gap electrical strength are discussed. D.E.R.

N63-14911 Air Force Systems Command. Foreign Technology Div., Wright-Patterson AFB, Ohio

VOLT-SECOND CHARACTERISTICS

In its Nature of the Long Spark Feb. 28, 1962 p 286-330 26 refs (See N63-14905 11-09)

The basic properties of the volt-second characteristics of a long spark are examined by experimental methods and analyzed by mathematical systems that are based on research data obtained from leader stage development. D.E.R.

N63-14912 Air Force Systems Command. Foreign Technology Div., Wright-Patterson AFB, Ohio

THE LONG SPARK: DC POWER SUPPLY AND LIGHTNING

In its Nature of the Long Spark Feb. 28, 1962 p 331–375 40 refs (See N63-14905 11-09)

The long spark in gaps formed by electrodes of various designs, when energy is applied to them from high and super-high electrostatic and cascade voltage generators, is examined. The development of lightning formed from a storm cloud is described assuming that, for a specific time interval, the cloud acts as a d.c. source.
D.E.R.

N63-14913 Air Force Systems Command. Foreign Technology Div., Wright-Patterson AFB, Ohio

THE LONG SPARK WITH COMMERCIAL-FREQUENCY ALTERNATING CURRENT

In its Nature of the Long Spark Feb. 28, 1962 p 376–423 17 refs
(See N63-14905 11-09)

A spark with 50-cycle alternating current is investigated, including: investigation of spark development, overall pattern of spark development, discharge characteristics of long gaps, and the effect of gap strengthening following discharge condensation.
D.E.R.

N63-14925 Applied Physics Lab., Johns Hopkins U., Silver Spring, Md.

TRANSIT SATELLITE PRECISION OSCILLATORS AND THEIR TEMPERATURE CONTROL

J. B. Oakes, W. J. Billerbeck, and K. F. Read Jan. 1963 93 p 6 refs
(Contract NOw-62-0604-c)
(CM-1025)

Four years have passed since the initiation of the Transit Navigational Satellite Program at APL. During this time, the stable oscillator which controls the RF signals transmitted from the satellite has undergone continuous refinement and improvement. At the present time, a design exists which appears to fulfill all the requirements for future operational use. This report describes the history of this development, and covers the electronic and thermal considerations which enter into the design. All pertinent schematic and mechanical drawings have been included.
Author

N63-14950 Naval Radiological Defense Lab., San Francisco, Calif.

XENON FLASHTUBES AS SOURCES OF THERMAL RADIATION

Kenneth A. Lincoln Jan. 23, 1963 40 p 33 refs
(DASA 1342; USNRDL-TR-617)

Thermal radiative properties of xenon flashtubes have been studied by measuring radiant energies per flash and peak irradiances incident on small objects located at the center of selected helical flashtubes. Methods are described for determining these properties by employing black-body calorimeters in conjunction with oscilloscopic presentation of intensity vs. time. Thermal pulses were found to be quite reproducible and are of the order of 1.0 to 1.7 cal/cm^2 per thousand joules of electrical input energy, depending on the type of flashtube. Peak irradiances of over 7,000 cal-cm^{-2}sec^{-1} were observed, and the influence of varying the capacitance and voltage was also determined. In addition, some electrical characteristics of the flashtubes, such as current and resistance, were included in the measurements.
Author

N63-14976 Case Inst. of Tech., Cleveland, Ohio

MICROPOWER TRANSISTOR LOGIC CIRCUITS

John C. Sturman (M. S. Thesis) 1962 116 p 21 refs
Parts of this thesis previously announced as NASA-TN-D-1462
See N63-12704 06-09

Conventional logic circuits and the limitations of scaling them down to micropower operation are discussed. Special attention is given to two basic circuits, differing from those normally used in that their output is not limited by a resistor forming the d.c. load of the stage. Instead, two transistors alternately clamp the output to the supply voltage or to ground. One of these circuits is an adaptation of a high-efficiency multivibrator design; the other is an original circuit specifically developed for micropower use. A detailed analysis of these two circuits is presented, and a variety of logic elements are derived from them. Sufficient information on the limitations of these circuits, device parameters and their variation, and design criteria is presented for the design of a number of useful micropower circuits suitable for space applications. Operating rates of these circuits range from 1 to 100 kilocycles and power levels from one to several hundred microwatts.
Author

N63-14996 Westinghouse Electric Corp. Westinghouse Research Labs., Pittsburgh, Pa.

THEORETICAL AND EXPERIMENTAL RESEARCH TO ASSIST IN PREPARATION AND DESIGN OF A HIGH FREQUENCY SILICON CARBIDE ACTIVE DEVICE Final Report

H. C. Chang Dec. 1962 66 p 21 refs
(Contract AF 19(604)-8499)
(AFCRL-62-61)

For an active device to be usable at temperatures in excess of 500° C, it is necessary that the base material have a large band gap. Of the presently known semiconductors, silicon carbide appears to be the most feasible material for use as a high-frequency device capable of operation at elevated temperatures. A unipolar transistor structure has been investigated, since a field-effect device most nearly fits the peculiar capabilities of silicon carbide. The device requirements are stringent and require a large degree of control over the crystal junction structure. This control is best effected by the epitaxial growth technique. An epitaxial growth reactor has been fabricated and epitaxial layers have been grown on hexagonal silicon carbide seed crystals. The best layers have been shown to possess a high degree of crystalline perfection and are quite pure.
Author

N63-15029 Utah U. Microwave Devices Lab., Salt Lake City

MICROWAVE DEVICES LABORATORY Consolidated Quarterly Report for the Period Oct. 1, 1962 to Dec. 31, 1962

L. S. Bowman et al Dec. 31, 1962 50 p 17 refs
(Contracts AF 04(647)-745 and AF 33(657)-8677; Nonr 1288 (05); and NSF Grant 15017)
(MDL-Q3)

Electron beam devices, solid state devices, and plasmas were studied to extend the useful frequency spectrum from the microwave to optical frequency range, and to improve existing devices and techniques in the microwave spectrum. A 30-40 kmc multiple, ladder-circuit backward-wave oscillator, dielectric slow wave circuits, the orbitron amplifier, a cyclotron-synchronous wave amplifier, multiple beam interactions, and magnetoelectric beam compression were studied under electron beam devices. The solid state studies covered: irradiated laser materials, tunneling, and millimeter wave masers. The plasma studies involved plasma waves, plasma generation and measurements, microwave plasma measurements, rocket exhausts, and thermionic emission from condensed species in rocket exhausts.
A.R.B.

N63-15066 Rome U. Ist. di Elettronica (Italy)

MODES WITH COMPLEX PROPAGATION CONSTANT IN RECTANGULAR GUIDES LOADED WITH TRANSVERSELY MAGNETIZED LOSSLESS FERRITE Technical Report No. 5

Giorgio Barzilai and Giorgio Gerosa June 20, 1962 6 p 2 refs
(Contract AF 61(052)-101)

The complete modal spectrum in the complex plane of the propagation constant for a rectangular guide, partially filled with transversely magnetized lossless ferrite, has been investigated and some numerical calculations have been carried out.
Author

N63-15097 Michigan U. Electron Physics Lab., Ann Arbor

EFFICIENCY ENHANCEMENT BY PHASE FOCUSING AND COLLECTOR DEPRESSION

J. E. Rowe Griffiss AFB, N. Y., Techniques Lab., Sept. 1962 14 p 4 refs
(Contract AF 30(602)-2834)
(RADC-TDR-62-470)

A theoretical study of the efficiency enhancement possible through collector segmentation and depression is made using information obtained from the nonlinear interaction theory for traveling-wave-like devices. The velocity characteristics of the spent beam are used directly to calculate the improvement factors and the optimum collector segment potentials as functions of various operating parameters. Specific calculations are made for both maximum gain and maximum power output operating conditions. Also efficiency improvement through phase focusing is discussed and experimental data are given and correlated with the theoretical predictions. It is found that improvement factors of approximately 1.5 to 2 are predicted, and similar results are obtained experimentally. Results are also given for the backward-wave oscillator, for which the improvement factor is higher due to the low interaction efficiency and the corresponding low velocity spread in the spent beam. Author

N63-15108 Eidgenössische Technische Hochschule, Zurich (Switzerland)
TEMPERATURVERHALTEN UND ANWENDUNGSBEISPIELE VON ELEKTRONISCHEN SCHALTERN MIT KOMPLEMENTAREN TRANSISTOREN [TEMPERATURE BEHAVIOR AND EXAMPLES OF USE OF ELECTRONIC SWITCHES WITH COMPLEMENTARY TRANSISTORS]
Andreas Eduard Bachmann (Ph. D. Thesis) 1962 33 p 31 refs Pt. I repr. from Tech. Mitt. PTT (Bern), Ser. 39, no. 12/1961 p 401-416 Pt. II repr. from Tech. Mitt. PTT (Bern), Ser. 40, no. 1/1962 p 19-28 In German; English summary
(*Its* Prom. 3167)

The characteristics of electronic bistable switches using complementary-type transistors are investigated, based on the equations of the ideal junction transistor. Special attention is given to the behavior of the switching characteristic when the temperature is changed. Thorough measurements on typical switches have been made to verify the calculations. According to the number of external leads, the switches are called complementary transistor diode-, triode- or tetrode-switch. Possible applications as they might be used, e.g., in the telephone field, are shown. A discussion is given of general lock-out circuits. Author

10 FACILITIES

Includes: airports; lunar and planetary bases; ground support systems; related logistics; simulators; test facilities (e.g., rocket engine test stands and wind tunnels); test ranges; and tracking stations.

***For related information see:* 06 Auxiliary Systems.**

N63-14722 General Electric Co. General Engineering Lab., Schenectady, N.Y.
MOLECULAR FLUX DISTRIBUTION IN AN AEROSPACE CHAMBER—ANALYSIS OF GAS KINETICS Summary Report
C. A. Tsonis Arnold Engineering Development Center 1963 90 p
(Contract AF 40(600)-954)
(AEDC-TDR-63-88)

The purpose of this investigation was to determine analytically the molecular incidence rates on the various surfaces of the space simulator. The mathematical model of the space simulator consists of two concentrically located spherical surfaces corresponding to the chamber wall outside and to the vehicle inside. The analysis is divided into two phases. Phase I deals with conditions of uniform pumping and outgassing on each surface. Phase II is an analysis of the nonuniform case introduced by surface discontinuities of axiosymmetric type. The problem was approached from a computer point of view with which computer solutions with a high degree of accuracy were obtained. Author

N63-14787 Naval Research Lab., Washington, D.C.
THE DEVELOPMENT OF A COMBINATION RUNWAY FOAMING-TANKER VEHICLE FOR AUGMENTING NAVAL AIR STATION FIRE FIGHTING OPERATIONS
H. B. Peterson, R. L. Gipe, and R. L. Tuve Jan. 31, 1963 22 p 2 refs
(NRL-5887)

A vehicle to combine the functions of foaming runways for emergency aircraft landing and serving as a "nurse" truck to resupply water and foam concentrate to aircraft firefighting vehicles has been constructed. This vehicle is to serve as a prototype to illustrate and define some of the features deemed critical for successful operations. Certain elements are left flexible so that conversions can be made from different large-capacity tank vehicles. Author

N63-14811 National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.
SIMILITUDE IN THERMAL MODELS OF SPACECRAFT
S. Katzoff Washington, NASA Apr. 1963 29 p 3 refs
(NASA TN D-1631) OTS: $0.75

Scaling criteria for the design and testing of thermal models of spacecraft are discussed. Four dimensionless similitude parameters are derived concerning radiation, internal heat generation, thermal conductivities of materials, and heat capacities of materials. Difficulties in achieving accurate simulation are pointed out, and methods of effecting comprises without seriously affecting the validity of the data are suggested. The most difficult problems appear to be the accurate scaling of thermal conductivity and heat capacity. For manned spacecraft, some additional discussion is given of similitude criteria for the convective heat transfer. Author

N63-15000 Chance Vought Corp. Astronautics Div., Dallas, Tex.
A SURVEY OF ARC-IMAGING FURNACES
D. J. Tillian Dec. 3, 1962 33 p
(Rept. 00.112)

Since the arc-imaging furnace is a versatile laboratory device for evaluating materials at extreme temperatures, the arc-imaging facilities in the United States are described. Information included for each facility includes: firm/agency, name of research director, facility type, power supply, arc source, optical system, maximum run time, temperature, heat flux range, sample size, instrumentation, research programs in progress or planned, and reports available. M.P.G.

N63-15113 Aro, Inc., Arnold Air Force Station, Tenn.
MECHANICAL DESIGN OF THE 50-INCH MACH 10-12 TUNNEL
Charles M. Howard and H. T. Wood, Jr. Arnold Engineering Development Center, Apr. 1963 78 p 4 refs
(Contract AF 40(600)-1000)
(AEDC-TDR-62-229)

The design of a 50-inch-diameter, continuous-flow, Mach 10 to 12 wind tunnel, currently operating at Mach 10 only, is described and related operational experience discussed. The tunnel is equipped with an axisymmetric, contoured nozzle and with a fast model injection/retraction system. Control and data readout systems are described. Author

N63-15125 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

NASA SPACE RADIATION EFFECTS LABORATORY

John Duberg and Emanuel Rind *In* Atomic Energy Commission. Div. of Tech. Inform., Wash., D. C. Protection against Radiation Hazards in Space Proc. of the Symp. at Gatlinburg, Tenn., Nov. 5-7, 1962 p 201-219 10 refs (See N63-15114 11-28) OTS: $7.00 (Paper B-3)

NASA, Langley Research Center, Virginia, has proposed a ground-based Space Radiation Effects Laboratory which simulates most of the particulate energy spectrum found in space, and can be used in an effective, accelerated, radiation-research program by means of which deleterious radiation effects can be minimized or eliminated. To achieve these results in a minimum time, a 600-Mev. proton synchrocyclotron of proven design, with variable energy and variable external beam size, as well as a 1- to 30-Mev electron accelerator with the same capabilities, has been incorporated into the proposed facility. Although these devices will be used as engineering tools, provision has been made to maintain the basic research capabilities of these accelerators. The plan of the proposed test areas reflects the latest advances in the state-of-the-art as it pertains to both the engineering and basic experimental requirements in flexibility, radiation background levels, shielding, and isolation. Author

N63-15184 Chance Vought Corp. Aeronautics and Missiles Div., Dallas, Tex.

CHANCE VOUGHT HYPERVELOCITY WIND TUNNEL TEST TECHNIQUES AND SAMPLE DATA

C. J. Stalmach, Jr., T. C. Pope and J. L. Lindsey Feb. 20, 1963 145 p 18 refs

(Rept. 2-59740/3R444)

Techniques of hypervelocity testing and sample data are presented for the Chance Vought Hypervelocity Wind Tunnel. Major topics include the tunnel, instrumentation, models, data processing, sample data, and test planning. Types of tests include force, dynamic stability, pressure, heat transfer, and rocket exhaust effects. This is a facility in the M = 14 to 21 range. Author

N63-15222 Aerojet-General Nucleonics, San Ramon, Calif.

ARMY GAS-COOLED REACTOR SYSTEMS PROGRAM: STUDY OF THE GCRE TUBE BUNDLE FAILURE 41 p 2 refs APPENDIX: FAILURE ANALYSIS OF GCRE BOLT AND SCUFF PLATE P[eter] F. Young 11 p 5 refs

Dec. 1962

(Contract AT(10-1)-880)

(IDO-28597)

The failure of the tube bundle section of the GCRE-I reactor, a test reactor associated with the ML-1 development program, is discussed in this report. The history of the fabrication, testing, and operation of the tube bundle is reviewed as well as the post-failure examination and metallurgical investigations. It is concluded that the failures occurred as a result of loss of coolant flow and subsequent boiling, which initiated complex corrosion processes in highly stressed areas of the pressure tubes in the region of the upper tube sheet coolant passages. Author

11 FLUID MECHANICS

Includes: boundary-layer flow; compressible flow; gas dynamics; hydrodynamics; and turbulence.

For related information see: 02 Aerodynamics of Bodies, Combinations, and Internal Flow, 03 Aerodynamics of Wings and Control Surfaces; 13 Heat Transfer; and 24 Physics, Plasma.

N63-14756 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

EFFECTS OF NOSE RADIUS AND EXTREME COOLING ON BOUNDARY-LAYER TRANSITION FOR THREE SMOOTH 15°-CONE-CYLINDERS IN FREE FLIGHT AT MACH NUMBERS TO 8.50

M. J. Krasnican and L. Rabb Washington, NASA, Mar. 1959 60 p 21 refs

(NASA MEMO 3-4-59E) OTS: $5.60 ph, $2.00 mf (Declassified)

Three highly polished 15° -included-angle cone-cylinders with hemispherical tips of several diameters (2, 3, and 4 in.) have been flown in order to obtain boundary-layer transition data at very low wall to local stream-temperature ratios, and heat-transfer data. All surfaces had a 2-microinch average roughness height. Laminar flow existed over the entire hemispherical nose of the 2- and 3-inch-tip-diameter models throughout the complete flight history. Extreme cooling to wall to local stream-temperature ratios at the sonic point as low as 0.20 did not cause transition on the nose for diameters as large as 3 inches. However, extreme cooling did cause early transition on the 4-inch model where it appears probable that transition occurred forward of the 45° station at a wall to local stream-temperature ratio of about 0.26. Variations in tip diameter influenced transition downstream of the nose under conditions of extreme cooling. The 2-inch-tip model was laminar at all cone-cylinder stations at temperature ratios as low as 0.32, whereas the 3- and 4-inch-tip models were turbulent at the same local flow conditions but at higher wall to local temperature ratios. Transition on the cone and cylinder of the 3- and 4-inch-tip bodies appeared to be sensitive to local Mach number, and occurred at higher local temperature ratios when values of local Mach number were higher. Increasing the nose diameter from 2 to 3 inches significantly changed the local flow conditions for which laminar flow existed on the cone-cylinder afterbody. However, a further increase in tip size to a 4-inch diameter had no discernable effect on the local flow conditions at transition. Author

N63-14776 Suffield Experimental Station (Canada)

SUFFIELD EXPERIMENTAL STATION SHOCK TUBE INSTRUMENTATION. IX. THE USE OF CONVENTIONAL SHOCK TUBES FOR THE GENERATION OF VERY LOW PRESSURE WAVES

W. A. Jones, F. L. Mc Callum, and J. C. Muirhead June 29, 1962 13 p 3 refs

(Suffield Technical Note 92)

Modifications are described that have been made to conventional shock tubes in order to obtain very low pressure waves. Two approaches were used. The first was to improve the diaphragm breaking mechanism of a constant cross-section shock tube in order to obtain good wave generation at low pressure. The second approach was to use a small cross-section compression chamber driving a larger cross-section expansion chamber. It is considered that the lower limit of the first approach is reached at $\Delta P_2 \approx 0.025$ psi, because of the difficulty in obtaining satisfactory diaphragm breaks at values of ΔP_4 less than 0.05 psi. However, there is no apparent lower limit to the pressures obtainable with the second approach. Author

N63-14778 Harry Diamond Labs., Washington, D.C.

FLUID AMPLIFICATION. 8. USE OF EPOXY CASTINGS FOR FLUID AMPLIFIER DESIGN

David S. Marsh and Edward V. Hobbs Feb. 11, 1963 14 p

(TR-1102)

An adjustable master unit has been used to make series of cast-epoxy fluid amplifiers that incorporate incremental dimensional changes. Subsequent unit testing identifies the best geometry for a given performance requirement. The process provides an inexpensive means of precisely producing the numerous units necessary for empirical design studies. The basic rubber mold and epoxy-casting process is described, as well as the adjustment of the

master unit. Some other uses of epoxy castings in the fluid-amplifier field are also described. Author

N63-14779 Harry Diamond Labs., Washington, D.C.
FLUID AMPLIFICATION. 9. LOGIC ELEMENTS
E. V. Hobbs Mar. 8, 1963 24 p 2 refs
(TR-1114)

Descriptions are given of the operation of various fluid logic elements—singly and in combination. Author

N63-14870 RAND Corp., Santa Monica, Calif.
INVARIANT IMBEDDING AND RAREFIED GAS DYNAMICS
J. Aroesty, R. Bellman, R. Kalaba, and S. Ueno Mar. 1963 15 p 4 refs
(ARPA Order 189-61; ARPA-SD-79)
(RM-3497-ARPA)

The techniques of invariant imbedding are applied to the study of rarefied gas flows. The problem of linearized Couette flow is investigated, and it is shown how the assumption of the Krook scattering model results in a formulation which is similar to that obtained in radiative transfer for conservative isotropic scattering in a plane-parallel atmosphere. By a simple enumeration of physical processes, the nonlinear integral-differential equation governing the reflection function is obtained, and a suitable transformation is shown to render this equation amenable to numerical computation. Author

N63-14874 Princeton U. Frick Chemical Lab., N.J.
ENERGY EXCHANGE IN SHOCK AND DETONATION WAVES Technical Report No. 4
D. F. Hornig Oct. 22, 1962 33 p 30 refs
(Contract Nonr-1858(24))

Energy transfer processes in shock and detonation waves in gases are investigated using an experimental setup in which an intense beam of monochromatic light is projected through a shock tube, so that when a shock wave passes through the beam, a pulse of reflected light is directed to a photomultiplier tube. The reflectivity is determined from the ratio of the intensity of the pulse to that of the monitor signal. Results indicate that when a shock-wave precedes the reaction zone in a detonation, transitional and rotational equilibrium is reached in the initial compression process, i.e., in 10 to 20 collisions. Vibrational relaxation was found to occur much more slowly (on the order of hundreds or thousands of collisions). Model calculations, using well-established reaction rates, show that the main heat evolution process in hydrogen-oxygen detonations occurs still later. Scattering observed in a zone extending about 2.5 mm back into the detonation wave suggests that complex wave structure and turbulence persist up to several atmospheres initial pressure. If so, the properties of detonations may be more affected by turbulent heat transfer than by molecular relaxation processes. M.P.G.

N63-14897 Stevens Inst. of Tech. Davidson Lab., Hoboken, N.J.
WAVE-RESISTANCE REDUCTION OF NEAR-SURFACE BODIES
King Eng and Pung N. Hu Mar. 1963 29 p 13 refs
(Contract Nonr-263(10))
(Rept. 933)

An analytical study of the wave-resistance characteristics of near-surface bodies was conducted to determine (1) for a given length and displacement, what changes in body-surface geometry are necessary to cause wave-resistance reduction, and (2) how geometrical change affects the wave-resistance behavior with Froude number and submergence depth. The general wave-resistance expression for a perturbed ellipsoid with the constraints of constant displacement and length is formulated. A digital computer solution of this variational problem is obtained for the case of the spheroid due to available computer-size limitations. The effects of fineness ratio and submergence-to-length ratio on the Froude number behavior of the wave resistance for a range of perturbations is demonstrated. Substantial reduction in wave resistance is possible for all Froude numbers above and slightly below the optimum Froude number for a particular perturbation distribution. For Froude numbers lower than approximately 10% below the optimum Froude number, a large increase in wave-resistance coefficient may be obtained depending upon the perturbation used. Since this generally occurs at low Froude numbers, the actual increase in total resistance experienced for perturbations yielding acceptable geometrical changes should be quite acceptable. Depending upon the optimum Froude number, the geometrical changes required for wave-resistance reduction fall into two classes: (1) midsection bulge with finer bow and stern for Froude numbers below 0.32; and (2) above 0.32 Froude number, a midsection pinch with bulging bow and stern. Author

N63-14959 Atomics International, Canoga Park, Calif.
CORRELATION OF LIQUID FRACTION IN TWO-PHASE FLOW WITH APPLICATION TO LIQUID METALS
C. J. Baroczy Apr. 15, 1963 43 p 22 refs
(Contract AT(11-1)-GEN-8)
(NAA-SR-8171) OTS: $1.00

This report presents a generalized correlation for liquid fraction in two-phase flow which is proposed for use with all fluids, including liquid metals. The correlation is based on isothermal, two-phase, two-component liquid fraction data for liquid mercury-nitrogen and water-air. Liquid fraction is shown to be a function of the Martinelli flow modulus and liquid/gas density and viscosity ratios. Good correspondence is indicated between the liquid fraction predicted by this correlation and the Martinelli-Nelson correlation for steam, experimental data for steam, and experimental data for Santowax R, an organic coolant. Prediction of liquid fraction by this method is shown for sodium, potassium, rubidium, and mercury. Application of the method to boiling mercury, for a range of temperatures and exit qualities, is demonstrated for SNAP systems. Author

N63-14966 Illinois U. Engineering Experiment Station, Urbana
A METHOD-OF-CHARACTERISTICS ANALYSIS OF DETONATION STABILITY Technical Report
Roger A. Strehlow Dec. 1962 17 p 32 refs
(AAE-62-2)

The effect of a time-dependent perturbation in reaction rate on a Zeldovich-von Neumann-Doring model of a Chapman-Jouguet detonation is considered. The analysis of a one-dimensional local change in reaction rate indicates that: (1) All portions of the reaction zone are affected by a local perturbation. (2) Temperature dependence of the reaction rate in the wave is the proper criterion for determining whether or not a detonation will be self-sustaining; a high-temperature dependence leads to an unstable wave. (3) Any detonation wave that exhibits local internal fluctuations cannot be classified as a CJ wave in the usual steady sense. (4) It should be difficult, if not impossible, to propagate a self-sustaining detonation in an inhomogeneous gas mixture. A preliminary analysis of the effect of a simple three-dimensional perturbation indicates that the infinitesimal changes in flow properties which arise are similar to the finite changes observed in spinning waves. Author

N63-15031 Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
THE LAMINAR BOUNDARY LAYER ON A DISK OF FINITE RADIUS IN A ROTATING FLOW. PART II: A SIMPLIFIED MOMENTUM-INTEGRAL METHOD
Leslie M. Mack Jan. 31, 1963 23 p 13 refs
(NASA Contract NAS7-100)
(JPL-TR-32-366) OTS: $2.60 ph, $0.89 mf

The solution of the tangential momentum equation is applied to the power-law outer flows treated in Part I of this report, and

also to the outer flows having the tangential velocity distribution of Burgers' vortex. The latter flow contains features of an actual outer flow over the entire disk. In contrast to Part I, a physically satisfactory solution is obtained at the center of the disk for the case where the outer flow is in solid-body rotation, and, furthermore, Stewartson's conjecture that this solution will be the solution for the disk of infinite radius is found to be correct. For the Burgers' vortex, the solution at the center is the infinite-radius solution based on the local angular velocity. It is found that when the angular velocity at the center of the disk becomes large compared to the angular velocity at the edge, the magnitude of the axial outflow velocity required to discharge the secondary flow from the boundary layer is no longer small compared to the tangential velocity of the outer flow. Author

N63-15033 Hamburg Model Basin (W. Germany)

ON OSCILLATING HYDROFOILS, PART II

S. Schuster (Berlin Towing Tank) and H. Schwanecke June 1962 39 p 7 refs

(Contract N-62558-2552)

The results of experimental investigations of the unsteady components of the hydrodynamic forces on hydrofoils are reported. These forces, the hydrodynamic exciting forces, and the hydrodynamic damping forces influence the vertical motions of the hydrofoils. It is found that they cannot be calculated by means of the linear differential equation that takes into account only the first harmonic excitation. Therefore, further research with respect to nonlinearities and other effects is recommended. D.E.R.

N63-15059 Polytechnic Inst. of Brooklyn, N.Y.

HIGH SPEED LOW DENSITY FLOW NEAR THE STAGNATION POINT OF A BLUNT BODY

Reuben Ru-ren Chow Wright-Patterson AFB, Ohio, Aeronautical Research Labs., Feb. 1963 58 p 20 refs

(Contract AF 33(616)-7661)

(PIBAL-765)

In the present analysis, the leading order shock conditions are obtained from the systematic order of magnitude analysis. A complete matching scheme for the components of heat flux and stresses between the shock and the boundary layer is proposed for the study of the flow field as well as the surface heat transfer to the body. No postulation, except the axial symmetry, has been made concerning the shape of the shock. The shape of the matching surface can be obtained uniquely from the present analysis. A method of solution has been introduced so that the laborious job of numerical integration of the flow equations with complicated boundary conditions can be bypassed. The governing equations are transformed and reduced to algebraic forms with the knowledge of the usual similarity solutions of the boundary-layer equations. Calculation has been performed for the specific case of $M_\infty = 5.7$ and $T_0 =$ the free-stream stagnation temperature $= 2100°$ R. The heat-transfer result at the stagnation point is in good agreement with the experimental value. The density and the stagnation enthalpy at the matching point are obtained as functions of the Reynolds number. They both show the appropriate asymptotic values of a discontinuous shock as the Reynolds number increases. The matching distance and the shock eccentricity are also obtained as functions of the Reynolds number. Author

N63-15090 Cornell U. Graduate School of Aerospace Engineering, Ithaca, N.Y.

STAGNATION POINT OF FLOW OF A VARIABLE PROPERTY FLUID AT LOW REYNOLDS NUMBERS

Michael Lenard June 1962 174 p 5 refs

(Contract AF 49(638)-544)

(AFOSR-2981)

Steady, viscous, two-dimensional and axially symmetric stagnation-point flows of a gas are considered for the case when the Reynolds number is too low for the applicability of the classical boundary-layer theory. It is assumed that the low-density gas is still a continuous fluid, permitting the use of the Navier-Stokes and associated equations as the basis of the problem. The effects of low Reynolds number are determined by applying an expansion procedure (similar to Lagerstrom and Cole) in terms of a parameter to the fluid-dynamical equations. It is shown that the following quantities are necessary to define the inviscid flow near the stagnation point: the stagnation properties of the gas, a velocity gradient, a nose radius, and a vorticity parameter. Further generalization of the inviscid flow by considering additional parameters is shown to be unnecessary, because any additional parameters will not affect the first-order corrections considered in the analysis of the viscous flow. The result of the analysis is that the following correction effects to boundary-layer theory are defined: curvature effect, displacement effect, velocity slip and temperature-jump effect, and vorticity effect (this last one for the axially symmetric case only). The magnitude of these effects was found to depend on the following parameters, respectively: the ratio of the boundary-layer thickness to nose radius, the change in stagnation-point velocity gradient from the inviscid value due to the displacement effect of the boundary layer around the body, the ratio of the mean free path to the boundary-layer thickness, and finally the ratio of the slope of the inviscid shear-flow profile (in axially symmetric flow only) to the average slope of the boundary-layer velocity profile. Some applications are discussed—in particular, the case of a blunt body flying through the atmosphere. Data from the calculations is presented in tabular and graphical form. Author

N63-15109 Eidgenössische Technische Hochschule, Zurich (Switzerland)

COMPRESSIBLE POTENTIAL FLOW THROUGH A THERMAL TURBINE

James Wilson Calder (Ph. D. Thesis) 1962 102 p 9 refs

(*Its* Prom 31-75)

Compressible potential flow through a thermal turbine is reviewed. Difficulties encountered in calculating three-dimensional flows are discussed and new methods of solution are presented. These methods are based on the assumption of flow profiles which are nearest to the true profiles. A new flow profile, which is, however, an approximation, is calculated by means of iteration methods. These methods can be repeated in order to obtain a more exact pattern of meridianal stream lines. An additional flow is added to the basic flow. This additional flow is calculated from constant source and sink distributions. The distribution of source strength is calculated from the fundamental flow, according to usual gas-dynamic methods. The boundary conditions are satisfied in that source layers are placed at the boundaries in such a manner as to produce velocities of desired magnitudes. Two examples were calculated. Results indicated that flow, in the case of a potential flow, between parallel walls, progresses as though compressibility has been included in the calculations, thus enabling a solution on two-dimensional flow. I.v.L.

N63-15112 Cornell Aeronautical Lab., Inc., Buffalo, N.Y.

A CORRESPONDENCE BETWEEN NORMAL-SHOCK AND BLUNT-BODY FLOWS

Walter E. Gibson and Paul V. Marrone June 1962 30 p 18 refs

(Contract DA-30-069-ORD-3443; ARPA Order 253-62; Proj. Defender)

(CAL-QM-1626-A-7)

The report describes an approximate solution for coupled, nonequilibrium chemistry along streamlines of inviscid, blunt-body airflows. The solution is derived from a correspondence between the chemical relaxation zone along a streamline and that behind a normal shock. This correspondence applies in general for Newtonian flows with binary kinetics. Along the stagnation streamline, binary kinetics are not required. The approximate solution is compared with exact numerical solutions of the blunt-body problem and

is found to be accurate for the high enthalpies corresponding to hypersonic flight. Author

N63-15176 Naval Ordnance Lab., White Oak, Md.

DETERMINATION OF THE STREAMLINES ON A SPHERE-CONE AT ANGLE OF ATTACK FROM THE MEASURED SURFACE PRESSURE DISTRIBUTION

E. L. Harris Feb. 18, 1963 24 p 1 ref

(Aerodynamics Res. Rept.-189; NOLTR-63-37)

A method is given for computing the inviscid fluid streamlines on a sphere-cone at an angle-of-attack in supersonic flow from the measured surface-pressure distribution. The boundary layer was assumed to be negligibly thin. The necessary equations are derived and put in a form suitable for programing on a digital computer. Author

N63-15182 Air Force Systems Command. Foreign Technology Div., Wright-Patterson AFB, Ohio

THE EFFECT OF A MAGNETIC FIELD ON THE FLOW OF A CONDUCTING GAS IN A PLANE TUBE IN THE PRESENCE OF HEAT TRANSFER THROUGH THE WALLS

E. P. Zimin May 11, 1962 8 p 1 ref Transl. from Izv. Akad. Nauk SSSR, OTD. Tekhn. Nauk: Mejhan. i Mashinostr. (Moscow), no. 2, 1961 p 117–119

(FTD-TT-62-333-1+2+4)

A quasi-one-dimensional approximation is made for the stationary flow of an electrically conducting compressible gas in a tube to determine the effect of a magnetic field. The derivation considers a homogeneous magnetic field that is applied normal to the tube and the heat transfer between the gas and ambient medium through the tube walls. R.C.M.

N63-15193 Deutsche Versuchsanstalt für Luft- und Raumfahrt. Inst. für Theoretische Gasdynamik, Aachen (W. Germany)

BETRACHTUNGEN ZUR ÄHNLICHKEIT REIBUNGSFREIER, KOMPRESSIBLER STRÖMUNGEN AN HAND DER INTEGRALSÄTZE [CONSIDERATIONS ON THE SIMILARITY OF A FRICTIONLESS COMPRESSIBLE STREAM TO THE DOMAIN OF THE INTEGRAL THEOREM]

M. Fiebig Nov. 1962 47 p 22 refs In German

(DVL-240)

Gas dynamic laws of similarity are derived for subsonic, sonic, supersonic, and hypersonic flows on the basis of integral theorems for frictionless gases. This method has the advantage of simplicity and in contrast to methods using differential equations, the uniformity of the dependent variables must not be assumed. This permits the consideration of compression shock at the beginning of the solution. Results indicate that the same laws of similarity are derived for subsonic, near sonic, supersonic, and hypersonic flows as would have been derived from the use of differential and shock equations. For the sake of simplicity, only two-dimensional flows were considered in this work. Trans. by I.v.L.

N63-15216 General Dynamics/Astronautics. Space Science Labs., San Diego, Calif.

SOME ASPECTS OF THE INTERACTION OF A JET WITH A DUST COVERED SURFACE IN A VACUUM ENVIRONMENT

M. Sibulkin and W. H. Gallaher Feb. 10, 1963 52 p 9 refs

(Supported by REA-111-9403)

(ERR-AN-244)

A small vacuum chamber has been used to study the action of a jet upon a surface covered with dust. A single nozzle, directed normal to the surface, was used. An approximation has been developed for the density distribution along the jet axis far from the nozzle. A simple mass-flow balance is used to estimate the shock wave standoff distance, and formulas for the shear and heat transfer in the region near the stagnation point are given. Information on dust-erosion patterns is given, with emphasis on the effects of nozzle-to-surface distance and on the appearance of annular-erosion patterns. An analytical model of the dust-erosion process is suggested which accounts for several of the trends observed experimentally. Author

N63-15218 Argonne National Lab., Ill.

A STUDY OF THE FLOW OF SATURATED FREON-11 THROUGH APERTURES AND SHORT TUBES

Hans K. Fauske and Tony C. Min (Minn. U.) Jan. 1963 21 p 13 refs

(Contract W-31-109-eng-38)

(ANL-6667)

An experimental study on the discharge rates of saturated and subcooled Freon-11 through apertures and short tubes is reported. The experiment covered a range of modified cavitation numbers between 0 and 500, length-to-diameter ratios of small diameter tubes between 2 and 55, and sharp-edge apertures of nine different geometric configurations. It was found that below the modified cavitation number of 10, the fluid exhibits completely metastable single-phase flow. When the modified cavitation number exceeds 14, two-phase critical flow may exist. In the range of modified cavitation numbers between 10 and 14, unstable transitional flow occurs (alternating single- and two-phase flow). Euler numbers for the apertures of various configurations, including square, rectangular, and eye-shaped, were found to be in the same order of magnitude as those for circular shapes. The triangular orifices were found to possess higher Euler numbers and the W-shaped orifices lower than the circular ones. Author

N63-15228 Deutsche Forschungsanstalt für Luft- und Raumfahrt. Inst. für Aerodynamik, Brunswick (W. Germany)

RECENT RESEARCH ON CASCADE FLOW PROBLEMS

H. Schlichting and A. Das Jan. 16, 1963 49 p 16 refs

(Partially supported by Deutsche Forschungsgemeinschaft)

(DFL-202)

A survey is given on extensive research work on cascade-flow problems carried out in recent years in Germany. For compressor cascades with blades of different thickness ratio, extensive measurements of the aerodynamic coefficients have been carried out in a wide range of Mach numbers and Reynolds numbers. For very low Reynolds numbers, as they occur for jet engines in very-high-altitude flight, the influence of turbulence on loss coefficients has been investigated. Comprehensive investigations on secondary flow losses are reported. Author

N63-15230 Maryland U. Inst. for Fluid Dynamics and Applied Mathematics, College Park

ON THE GENERATION OF SECONDARY MOTIONS IN THE FIELD OF A VORTEX

J. R. Weske and T. M. Rankin Mar. 1963 27 p 13 refs

(Grant AF-AFOSR-62-230)

(BN-313)

The investigation is concerned with motions in the region of the core of a vortex that exhibit peripheral vorticity. From theoretical reasoning, it appears that development of such motions is favored as a zonal maximum of axial vorticity components is produced, e.g., by divergence of the vortex core. Several experiments, devised to verify theoretical conclusions, furnish evidence that concentrations of vorticity periodic about the perimeter actually do occur as expected. Author

N63-15234 Eidgenössische Technische Hochschule, Zurich (Switzerland)

ÜBER DAS RHEOLOGISCHE VERHALTEN VON AEROSIL® IN WASSER [ON THE RHEOLOGICAL BEHAVIOR OF AEROSIL® IN WATER]

Peter Schaller (Ph.D. Thesis) Zurich, Juris-Verlag, 1962 120 p 80 refs In German
(Its PROM-3175)

The rheological behavior of Aerosil ®, which is a silica, was reviewed. Results indicate that: (1) Aerosil ® can be used as a viscosity-increasing stabilizer in certain materials. (2) Aerosil ® hinders the sedimentation of zinc oxide and talc suspensions. (3) Aerosil ® shows no appreciable stabilizing effect on titanium dioxide. (4) The loose flakes of Aerosils ® create in zinc oxide and talc suspension a loose three-dimensional network which includes water, the dispersion medium. (5) Silica causes a coagulation of fine particles of titanium dioxide which results in a subsidence of the newly created flakes. (6) The manner of procedure as well as the prescribed quantity of Aerosil ® is important in affecting stabilization. Faster and longer homogenation, in watery media, leads to smaller sedimentation effects. (7) Aerosil ® structure is disturbed by mechanical processing and requires more than twenty days for structure rebuilding. (8) Aerosil-containing suspensions form, with time, such a strongly cross-linked gel that they resemble salves. I.v.L.

12 GEOPHYSICS

Includes: auroral phenomena; upper atmospheric studies; cartography; geodesy; and geomagnetism.

***For Van Allen belts see:* 28 Space Radiation.**

***For related information see:* 05 Astronomy and Astrophysics; 21 Meteorology; and 29 Space Sciences.**

N63-14783 Naval Research Lab., Washington, D.C.
ATMOSPHERIC ELECTRICITY MEASUREMENTS IN THE NORTH ATLANTIC DURING FALLEX-60
R. V. Anderson and Eva Mae Trent Sept. 7, 1962 7 p 3 refs
(NRL-5833)

An atmospheric electricity station was installed aboard the USS Northampton in August 1960 and was operated during the fall NATO exercises by NRL personnel. The instrumentation proved to be completely seaworthy. The electric field meter was not sufficiently sensitive in this installation to give usable data, hence this study was restricted to measurements with the atmospheric conductivity meter. The behavior of the conductivity measurements was analyzed for the five occasions when fog was encountered; it was found that in most cases, as is also true on land, there was a significant decrease in the total atmospheric conductivity some 2 to 6 hours before the actual fog incidence. Indication was not given, however, prior to fog dissipation. Although data are not sufficient at present for definitive conclusions, it appears that atmospheric electric conductivity may be a supplemental tool in fog forecasting. Author

N63-14817 Council of Scientific and Industrial Research. Radio Research Committee, New Delhi (India)
IONSOPHERIC DATA
May 1962 58 p
(RRC-A84)

All ionospheric and radio propagation data collected in India during the month of May 1962 are presented. The regular observations are taken at eight stations in India, ranging in geomagnetic latitude from 19.2° N to 0.9° S; all the stations are in the 75° E longitude zone. D.E.R.

N63-14818 Council of Scientific and Industrial Research. Radio Research Committee, New Delhi (India)
IONOSPHERIC PREDICTIONS FOR JUNE 1963
Jan. 1963 5 p
(RRC-B81)

Scaled graphs depict: predicted median values for the ordinary ray critical frequencies for the East Zone; and predicted median values for the maximum usable frequencies for 4000 km for the East Zone. A.R.B.

N63-14859 Aeronautical Chart and Information Center, St. Louis, Mo.
RELATIONSHIP OF THE FLATTENING TO THE SECOND AND FOURTH POTENTIAL HARMONICS AND THEIR DETERMINATION FROM ORBITAL DATA
James L. Dragg Mar. 1962 29 p 26 refs
(Tech. Memo. TM-18)

This paper presents the theory, method, and formulas for determining the coefficients of the second and fourth zonal harmonics of the earth's gravitational potential from satellite data. The formula for determining the earth's flattening is given under the assumption that the earth has the shape of a uniform ellipsoid of revolution. A discussion and a table of previous determinations of the coefficients, J_2 and J_4, and the flattening, f, are given. A new determination of the coefficients and flattening from the satellites $1958\beta_2$, 1959_{ϵ_1}, and $1960\eta_2$ is made, including the essential formulas and procedure with an error analysis. Author

N63-14968 Aeronautical Chart and Information Center, St. Louis, Mo.
GEOCENTRIC COORDINATES OF OBSERVATION SITES Technical Instruction No. TI-11
Mar. 1962 43 p 4 refs

This paper presents a method for computing geocentric rectangular coordinates of observation sites, using information which has been derived from the reduction of photographic plates and orbital data. Procedures for determining geodetic coordinates of the observer's position and the height between the position and an earth-centered ellipsoid are included. A complete error analysis of the results is also included along with examples designed to contribute to a clearer understanding of the procedures. Author

N63-14974 National Aeronautics and Space Administration, Washington, D.C.
PRELIMINARY RESULTS OF EXPLORER XVII ANNOUNCED News Release No. 63-79
Apr. 18, 1963 3 p
Available from NASA. Office of Scientific and Technical Information, Wash., D.C.

A preliminary analysis of the data received from Explorer XVII on the first day after launch indicates that the earth is surrounded by a belt of neutral helium atoms. At the satellite perigee of 150 miles, 60-million neutral helium molecules/cm^3 were observed; at the satellite apogee of 575 miles, the measured concentration was about one million helium molecules/cm^3. The atmospheric density measured by the satellite pressure gages at perigee was 2.7×10^{-8}gm/cm^3. Measurements of electron temperature by Explorer XVII confirmed other satellite data showing that these temperatures vary from day to night, and that during the night the temperatures remain near the same level for both apogee and perigee. The average nighttime electron temperature measured was about 850° K; the average daytime temperature was about 2200° K. M.P.G.

13 HEAT TRANSFER

Includes: ablation; cooling; heating; and other thermal effects.

For aerothermodynamics see: 02 Aerodynamics of Bodies, Combinations, and Internal Flow; and 03 Aerodynamics of Wings and Control Surfaces.

For combustion see: 26 Propellants and Combustion.

For related information see: 11 Fluid Mechanics.

N63-14726 Gt. Brit. Ministry of Aviation. Technical Information and Library Services, Mottingham

THEORY OF HEAT EXCHANGE IN BOILING (K TEORII TEPLOOBMENA PRI KIPENII)

V. I. Tolubinskii Mar. 1963 12 p 7 refs Transl. from Izvest. Vyssh. Ucheb. Zaved., Energ. (Minsk), v. 1, 1959 p 15-22 7 refs
(TIL/T-5387)

The unsatisfactory nature of existing criterial equations to describe nucleate boiling is pointed out. As a preliminary to attempting to find a satisfactory equation, an analysis is made of the factors involved in the boiling and heat-exchange processes. Two equations are produced which are considered satisfactory for generalized solutions to practical problems. Author

N63-14765 National Aeronautics and Space Administration. Langley Research Center, Langley Field, Va.

AN EXPERIMENTAL INVESTIGATION OF ABLATING MATERIALS AT LOW AND HIGH ENTHALPY POTENTIALS

Bernard Rashis and Thomas E. Walton, Jr. Washington, NASA, Mar. 1960 37 p 10 refs
(NASA TM X-263) OTS: $3.60 ph, $1.31 mf (Declassified)

The ablation performance characteristics of a number of materials were derived from tests conducted in a Mach number 2.0 ethylene-heated high-temperature air jet having a maximum stagnation enthalpy potential of approximately 1,200 Btu/lb. The tests were conducted with 6-inch-diameter blunt-nose shapes. The surface of most of the materials after testing was generally smooth, and the unablated portions of the specimens were, in appearance, the same as before testing. In all cases, the back or inside surface of the specimens exhibited no evidence of heating. An evaluation of the enthalpy potential effect was obtained by comparison of the present data with previous tests conducted, on the 6-inch-diameter blunt-face configuration, in a subsonic arc-heated air jet. The stagnation enthalpy potential of this facility was approximately 7,000 Btu/lb. For Teflon, the effective heat of ablation increased from approximately 1,250 Btu/lb to 3,900 Btu/lb when the stagnation enthalpy potential was increased from 800 Btu/lb to 7,000 Btu/lb. Author

N63-14800 ManLabs, Inc., Cambridge, Mass.

THERMODYNAMICS OF INTERSTITIAL SOLID SOLUTIONS Final Report [Sept. 1961-Sept. 1962]

Larry Kaufman and Harold Bernstein Sept. 1962 65 p 26 refs
(Contract AF 33(616)-6788)
(ASD-TR-61-445, Pt. II)

The thermodynamics of interstitial solid solutions and nonstoichiometric compounds have been applied to an analysis of the Ti-O system to evaluate explicitly the contributions of positional and vibrational entropy, zero point enthalpy, and the free energy of formation of vacancies to the thermodynamic properties of h.c.p., b.c.c., and NaCl type phases in this system. Application of the results to calculations of phase equilibria, heats of formation, vapor pressure data, specific heats and vacancy concentrations over a wide range of composition and temperature compare favorably with experimental observations. X-ray measurements of the Debye temperature performed on a series of high-melting carbides, nitrides, and oxides are compared with reported entropies of these compounds and predictions based on the "two-Debye" temperature and Lindemann approximations. Author

N63-14815 Mechanical Technology, Inc., Latham, N.Y.

SOME THERMAL EFFECTS IN EHD LUBRICATION WITH TEMPERATURE DEPENDENT VISCOSITY OF SLIDING SURFACES

C. W. Ng Feb. 1963 34 p 9 refs
(Contract Nonr 3729(00) (FBM))
(MTI-62TR41)

The influence of two dependent variables in elastohydrodynamics, pressure, and temperature are mathematically analyzed to estimate the significance of various thermal and pressure effects and to formulate an analysis for the related thermoelastic problem. The results are readily adaptable to numerical calculation. D.E.R.

N63-14857 Aro, Inc., Arnold Air Force Station, Tenn.

SOME ASPECTS OF ENERGY TRANSFER IN THE ELECTRODE AND SETTLING SECTIONS OF AN ARC-HEATED WIND TUNNEL

William H. Carden Arnold Engineering and Development Center, Apr. 1963 36 p 4 refs
(Contract AF 40(600)-1000)
(AEDC-TDR-63-72)

A calorimetric investigation of certain energy-transfer processes in the settling region of an arc-heated wind tunnel has been made. The effects of anode length and diameter on heat-transfer rates in the stilling chamber have been studied for a range of flow conditions. A radiation-cooled heat shield for use in the stilling chamber has been proposed and evaluated. A 20-percent reduction in the stilling chamber heat loss and a five-percent gain in overall efficiency are indicated with the installation of a suitable heat shield. Author

N63-14981 Bureau of Mines. Explosives Research Lab., Pittsburgh, Pa.

RESEARCH ON THE HAZARDS ASSOCIATED WITH THE PRODUCTION AND HANDLING OF LIQUID HYDROGEN

M. G. Zabetakis and D. S. Burgess 1961 58 p refs
(BM-RI-5707)

Unconfined liquid hydrogen was studied to determine the danger of explosion and related hazards so as to devise emergency procedures for: protecting personnel and equipment when an accidental spillage of liquid hydrogen occurs and establishing a quantity-distance table for the storage of this fuel. It was found that the chief hazards associated with the use of liquid hydrogen in unconfined spaces are those attributed to the formation of shock sensitive condensed (liquid hydrogen-solid oxygen) mixtures and to fire. The quantity-distance table for liquid hydrogen is based on the radiation and flame size, derived in this study. A.R.B.

N63-15001 Brookhaven National Lab., Upton, N.Y.

PROCEEDINGS OF 1962 [SECOND ANNUAL] HIGH-TEMPERATURE LIQUID METAL HEAT TRANSFER TECHNOLOGY MEETING, MAY 17-18, 1962 Sponsored by the Engineering Development Branch, Division of Reactor Development, Atomic Energy Commission at Brookhaven National Laboratory

May 1963 406 p 85 refs
(BNL-756(C-35)) OTS: $5.00

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N63-15002 Atomic Energy Commission. Div. of Reactor Development, Washington, D. C.

DEVELOPMENT PROBLEMS OF SNAP REACTOR SYSTEMS

G. Montgomery Anderson *In* Brookhaven National Lab. Proc. of 1962 [Second Annual] High-Temp. Liquid-Metal Heat Transfer Technol. Meeting, Brookhaven Natl. Lab., Upton, N. Y., May 17–18, 1962 p 1–18 (See N63-15001 11-13) OTS: $5.00

A discussion of the developmental problems of SNAP reactor systems includes: (1) weight distribution for nuclear turboelectric space systems, (2) specific weights of alkali metal direct condensing radiators, (3) system lifetime *vs.* operating temperatures, (4) tube strengths and fuel dissociation pressures for SNAP 8 conditions, (5) diffusion of hydrogen through metals and glasses, and (6) a thermoelectric converter module. I.v.L.

N63-15003 Pratt and Whitney Aircraft, Middletown, Conn.

ALKALI METAL PHYSICAL PROPERTIES PROGRAM AT PRATT AND WHITNEY AIRCRAFT-CANEL

R. E. Cleary and S. M. Kapelner *In* Brookhaven National Lab. Proc. of 1962 [Second Annual] High-Temp. Liquid-Metal Heat Transfer Technol. Meeting, Brookhaven Natl. Lab., Upton, N.Y., May 17–18, 1962 p 19–39 3 refs (See N63-15001 11-13) OTS: $5.00 (Contract AT(30-1)-2789)

The use of alkali metals in liquid-metal heat-transfer nuclear reactors is discussed. Emphasis is placed on the determination of the high-temperature properties of the alkali metals, such as electrical resistivity, thermal conductivity, solubility of noble gases in alkali metals, viscosity, wetting characteristics, and vapor pressure and density. D.E.R.

N63-15004 Columbia U. Liquid Metals Research Lab., New York, N.Y.

VAPOR PRESSURE OF ALKALI METALS, III. RUBIDIUM, CESIUM, AND SODIUM-POTASSIUM ALLOY (NaK) UP TO 100 POUNDS PER SQUARE INCH

Charles F. Bonilla, Dulari L. Sawhney, and Munzer M. Makansi *In* Brookhaven National Lab. Proc. of 1962 [Second Annual] High-Temp. Liquid-Metal Heat Transfer Technol. Meeting, Brookhaven Natl. Lab., Upton, N.Y., May 17–18, 1962 p 40–63 12 refs (See N63-15001 11-13) OTS: $5.00

(Contracts AT(30-1)-1092, AT(30-1)-1101, and AT(30-1)-2660)

An apparatus has been constructed that accurately measures the vapor pressures (up to 100 p.s.i.) of the liquid alkali metals. These measurements are very useful in most heat exchange systems using liquid metals. The vapor pressure of rubidium, cesium, and sodium-potassium alloys have been measured as well as that of sodium and potassium themselves. D.E.R.

N63-15005 Battelle Memorial Inst., Columbus, Ohio

CURRENT STATUS OF THE RESEARCH PROGRAM ON THE ENGINEERING PROPERTIES OF POTASSIUM

Joseph F. Walling *In* Brookhaven National Lab. Proc. of 1962 [Second Annual] High-Temp. Liquid-Metal Heat Transfer Technol. Meeting, Brookhaven Natl. Lab., Upton, N.Y., May 17–18, 1962 p 64–76 (See N63-15001 11-13) OTS: $5.00
(NASA Contract NAS5-584)

Some thermodynamic and transport properties of potassium between 900° and 2100° F are measured. The specific properties being measured are: vapor pressure, specific heat, thermal conductivity, viscosity, vapor compressibility, and vapor heat. Data are currently available for the vapor pressure, liquid viscosity, and specific heat of potassium. These properties are discussed in terms of application in high-temperature liquid-metal heat-transfer systems. D.E.R.

N63-15006 Aerojet-General Nucleonics, San Ramon, Calif.
RUBIDIUM-CESIUM EVALUATION PROGRAM THERMODYNAMIC PROPERTY MEASUREMENTS
D. L. Cochran *In* Brookhaven National Lab. Proc. of 1962 [Second Annual] High-Temp. Liquid-Metal Heat Transfer Technol. Meeting, Brookhaven Natl. Lab., Upton, N. Y., May 17–18, 1962 p 77–96 5 refs (See N63-15001 11-13) OTS: $5.00
(Contracts AT(04-3)-251 and AT(04-3)-368)

This paper summarizes thermodynamic property measurements on Rb and Cs which have been made by Aerojet-General Nucleonics. Density of saturated liquid between the melting temperature and 1350° F and vapor pressure between 1000° and 1800° F are presented for both Rb and Cs. Author

N63-15007 Atomics International, Canoga Park, Calif.
SUMMARY OF SODIUM BOILING AND CONDENSING STUDIES
R. C. Noyes *In* Brookhaven National Lab. Proc. of 1962 [Second Annual] High-Temp. Liquid-Metal Heat Transfer Technol. Meeting, Brookhaven Natl. Lab., Upton, N. Y., May 17–18, 1962 p 97–113 6 refs (See N63-15001 11-13) OTS: $5.00
(Contract AT(11-1)-GEN-8)

A summary of the sodium boiling and condensing studies begun in 1959 is presented. Forced convection boiling studies are planned for late 1963, and the loop and preliminary component studies are described. The pool boiling experiments have been completed and some results are included, such as: heat transfer, heat flux, and heat conduction data. Sodium condensing heat-transfer studies were primarily concerned with condensing in the presence of noncondensable gases. The sodium heat-transfer rate was measured in both argon and helium. These measured condensing heat-transfer coefficients are given as a function of the amount of noncondensable gas present. The heat-transfer coefficients for nucleate boiling and condensing of sodium were found to be high, as predicted. It is concluded that no significant resistance to condensing heat transfer for liquid metals would exist unless noncondensing gases were present. D.E.R.

N63-15008 Michigan U., Ann Arbor
LIQUID METAL BOILING STUDIES
Richard E. Balzhiser *In* Brookhaven National Lab. Proc. of 1962 [Second Annual] High-Temp. Liquid-Metal Heat Transfer Technol. Meeting, Brookhaven Natl. Lab., Upton, N. Y., May 17–18, 1962 p 114–125 3 refs (See N63-15001 11-13) OTS: $5.00
(Supported by Aeronautical Systems Div.)

Liquid-metal boiling studies conducted at the University of Michigan are summarized. The experimental programs include: nucleate pool boiling, film boiling, pool boiling in agravic fields, and forced circulation studies. Potassium is used in all the studies with the exception of the agravic field study which uses mercury. The purpose of the studies is to analyze the boiling regime, critical flux, transition regime, and surface phenomena of heat transfer in the boiling substance. D.E.R.

N63-15009 Wisconsin U., Madison
POOL BOILING OF SODIUM
Max W. Carbon *In* Brookhaven National Lab. Proc. of 1962 [Second Annual] High-Temp. Liquid-Metal Heat Transfer Technol. Meeting, Brookhaven Natl. Lab., Upton, N. Y., May 17–18, 1962 p 126–130 (See N63-15001 11-13) OTS: $5.00

A description of the experimental equipment and some preliminary results of the studies at the University of Wisconsin on heat transfer in the pool boiling of sodium are covered. The initial aim of the program is to obtain burnout data at one atmosphere of pressure with zero subcooling. D.E.R.

N63-15010 General Electric Co. Flight Propulsion Lab. Dept., Cincinnati, Ohio
ALKALI METALS BOILING AND CONDENSING INVESTIGATIONS
R. D. Brooks *In* Brookhaven National Lab. Proc. of 1962 [Second Annual] High-Temp. Liquid-Metal Heat Transfer Technol. Meeting, Brookhaven Natl. Lab., Upton, N.Y., May 17–18, 1962 p 131–154 (See N63-15001 11-13) OTS: $5.00
(Sponsored by NASA)

The investigation of alkali metal boiling and condensing is now nearing the completion of the first period of work. Preliminary results have been obtained in this program for forced convection for boiling and condensing in single tubes with potassium. Pool boiling data have been obtained as part of this program. Three forced-convection experiments have been put into operation with heat-transfer capabilities from 50 to 300 kw at the test sections. The purpose of this paper is to report on the characteristics of the experimental systems and to review the data being obtained. Author

N63-15011 Garrett Corp. AiResearch Mfg. Div., Los Angeles, Calif.
LIQUID METAL HEAT TRANSFER TEST PROGRAMS
James J. Killackey *In* Brookhaven National Lab. Proc. of 1962 [Second Annual] High-Temp. Liquid-Metal Heat Transfer Technol. Meeting, Brookhaven Natl. Lab., Upton, N. Y., May 17–18, 1962 p 155–181 2 refs (See N63-15001 11-13) OTS: $5.00

Results of the liquid-metal heat-transfer programs are reported. Data for the forced convection boiling of potassium at temperatures up to 1480° F are presented. Stable flow boiling, without evidence of exceeding the critical heat flux, was obtained at a heat flux of 320,000 Btu per hr-ft^2 at a 15 percent average vapor quality. A description of lithium hydride handling procedures, developed as a part of the experimental evaluation of a solar heat receiver, is included. D.E.R.

N63-15012 Oak Ridge National Lab., Tenn.
FORCED-CONVECTION SATURATION BOILING OF POTASSIUM AT NEAR-ATMOSPHERIC PRESSURE
H. W. Hoffman and A. I. Krakoviak *In* Brookhaven National Lab. Proc. of 1962 [Second Annual] High-Temp. Liquid-Metal Heat Transfer Technol. Meeting, Brookhaven Natl. Lab., Upton, N. Y., May 17–18, 1962 p 182–203 8 refs (See N63-15001 11-13) OTS: $5.00

The study of forced-convection saturation boiling of potassium at near-atmospheric pressure has been expanded to a consideration of the general ramifications of a direct-cycle boiling-potassium reactor system for auxiliary space-power application. Within the redefined program, the heat transfer and fluid mechanics aspects

have been extended to include: (1) the forced-convection saturation boiling of potassium in single vertical tubes (with and without swirl flow), in multiple tubes, and in interconnected passages (rod clusters); (2) flow stability with boiling as a function of boiler geometry, inlet fluid conditions, and boiler pressure drop; (3) the dynamics of liquid-vapor separation; (4) the fundamental characteristics of swirl-flow boiling with net vapor generation (with water); (5) the determination of selected thermophysical properties of liquid metals (e.g., the surface tension of the alkali metals at the boiling temperature); (6) the delineation of the hydrodynamics of two-phase flows in rod clusters; (7) condensation in straight and tapered tubes with and without swirl flow; and (8) the influence of component coupling in boiling systems. I.v.L.

N63-15013 Brookhaven National Lab., Upton, N.Y.

BOILING POTASSIUM HEAT TRANSFER PROJECT LOOP DESIGN AND DEVELOPMENT

J. C. Chen *In its* Proc. of 1962 [Second Annual] High-Temp. Liquid-Metal Heat Transfer Technol. Meeting, Brookhaven Natl. Lab., Upton, N.Y., May 17–18, 1962 p 204–218 (See N63-15001 11-13) OTS: $5.00

(Work performed for AEC)

(BNL-6142)

Basic heat-transfer characteristics of alkali metals in forced convective flow with phase change are reviewed in the light of the general purpose and immediate goals of this project. The first objective is to measure local boiling coefficients for potassium in vertical axial flow through a round pipe. Later, it is planned to measure critical heat fluxes, to determine the effects of swirl inducers, and to measure condensing coefficients. A forced convection loop is being built for these studies. The design is such that a portion of it may be regarded as a permanent facility into which interchangeable test components can be inserted for the various studies. I.v.L.

N63-15014 Aerojet-General Nucleonics, San Ramon, Calif.

RUBIDIUM-CESIUM EVALUATION PROGRAM HEAT TRANSFER AND FLUID FLOW STUDIES

C. R. Fisher *In* Brookhaven National Lab. Proc. of 1962 [Second Annual] High-Temp. Liquid-Metal Heat Transfer Technol. Meeting, Brookhaven Natl. Lab., Upton, N. Y., May 17–18, 1962 p 219–227 (See N63-15001 11-13) OTS: $5.00

A loop design for studying the boiling heat transfer and fluid flow characteristics of rubidium and cesium in forced convection is described. The primary structural material is niobium-1 zirconium. All parts of the loop in contact with fluid above 400° F are constructed of this material. The fluid is circulated in MSA style IV E M pumps. Two pumps are necessary to produce the required pressure rise at the maximum flow rates. Flow stability is enhanced by the use of a flow restriction between preheater and boiler. The flow in the loop is measured with a calorimetric flow meter. The preheater is a section of the loop in which heat is added by direct ohmic heating using a powerstat and step-down transformer. The testing section consists of four separate sections, each approximately one foot long. Pairs of thermocouples at the same axial station but different angular and radial stations will provide the temperature data required to calculate heat flux and inside temperature in the test section. All temperatures used to calculate heat transfer performance will be measured with tantalum sheathed, Pt, Pt-10 Rh thermocouples. Surface temperatures and heat flux with be measured by thermocouples inserted into the test section to an immersion depth of 3 inches. Fluid temperatures will be measured by thermocouples wired onto the surface of unheated sections. The fluid pressure will be measured at the entrance and exit of the test section. This will be accomplished by providing perpendicular dead legs at these points, terminating in volumetric pressure sensors. I.v.L.

N63-15015 Atomics International, Canoga Park, Calif.

HIGH TEMPERATURE BOILING MERCURY EXPERIMENT

C. J. Baroczy *In* Brookhaven National Lab. Proc. of 1962 [Second Annual] High-Temp. Liquid-Metal Heat Transfer Technol. Meeting, Brookhaven Natl. Lab., Upton, N. Y., May 17–18, 1962 p 228–235 (See N63-15001 11-13) OTS: $5.00

In order to provide a sound experimental and analytical basis for the design of mercury boilers, an apparatus is being designed to experimentally determine heat transfer characteristics of pool boiling and forced-convection boiling of mercury. The purpose of this apparatus is to achieve high-boiling heat fluxes (on the order of 1×10^6 Btu/hr/ft^2) at high-temperature levels (1000° F to 1400° F). The description of the apparatus is as follows: For the forced convection boiling tests, the test section consists of an approximately 3-foot-long, ¼-inch-diameter duplex tube. For pool boiling tests, the test section is 3 inches in diameter and 3 inches long. The inner tube is of low carbon steel and the outer tube is Inconel X or Haynes Alloy-25. The outer tube is plasma sprayed with a thin layer of either high purity alumina or boron nitride to provide electrical insulation. The electrical resistance layer (consisting of an Inconel X tube) is then fitted over the electrical insulation. A low voltage (30 volts maximum), high current, electrical source, utilizing a saturable-core reactor for control, will supply the required power. The power generated in the resistance layer is transferred to the inner tube surface by conduction. Sheathed, insulated thermocouples (.025 to .040 in. dia.) will be located in longitudinal grooves in the wall of the carbon steel tube to ensure reliable tube surface readings. By locating the thermocouples at different radial locations, it will be possible to measure the tube wall temperature gradient, heat flux, and, by extrapolation, the inner tube surface temperature. In addition, these temperatures will serve as a check on the heat flux obtained from the power input. The bulk temperature of the fluid will be obtained by means of immersing thermocouples in the fluid stream. I.v.L.

N63-15016 General Motors Corp. Allison Div., Indianapolis, Ind.

POTASSIUM-MERCURY AMALGAM, HEAT TRANSFER AND TWO-PHASE FLOW INVESTIGATION

C. R. Smith, Y. S. Tang, and P. T. Ross *In* Brookhaven National Lab. Proc. of 1962 [Second Annual] High-Temp. Liquid-Metal Heat Transfer Technol. Meeting, Brookhaven Natl. Lab., Upton, N. Y., May 17–18, 1962 p 236–261 5 refs (See N63-15001 11-13) OTS: $5.00

Potassium-mercury amalgam, heat transfer, and two-phase flow are investigated in the light of developing a regenerative, liquid-metal fuel cell. Emphasis is placed upon: (1) an evaluation of boiling potassium-amalgam heat-transfer coefficients and critical heat fluxes over a range of potassium-mercury compositions; and (2) liquid-metal, two-phase flow associated with the boiling phenomena. I.v.L.

N63-15017 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

LIQUID METAL RESEARCH AT NASA-LEWIS RESEARCH CENTER

James P. Lewis *In* Brookhaven National Lab. Proc. of 1962 [Second Annual] High-Temp. Liquid-Metal Heat Transfer Technol. Meeting, Brookhaven Natl. Lab., Upton, N.Y., May 17–18, 1962 p 262–275 (See N63-15001 11-13) OTS: $5.00

A summary is presented of the liquid-metal research activities at NASA Lewis Research Center with emphasis on the heat-transfer aspects of these studies. Areas of interest include studies of the mechanisms of boiling and condensing as opposed to studies of pumps and turbines. Types of programs vary from general research studies of liquid-metal two-phase flow and heat transfer to operational system programs as support of specific projects. All research

programs are primarily associated with the development of space power generating systems and specifically for the Rankine cycle turbogenerator. The metals currently being studied are sodium, potassium, and mercury. Operating fluid temperatures range from 700° F for mercury to over 2000° F for sodium. I.v.L.

N63-15018 Aeronautical Systems Div., Air Force Systems Command, Wright-Patterson AFB, Ohio

EXPERIMENTAL DETERMINATION OF OVERALL HEAT TRANSFER COEFFICIENTS FOR CONDENSING SODIUM

J. A. Roth *In* Brookhaven National Lab. Proc. of 1962 [Second Annual] High-Temp. Liquid-Metal Heat Transfer Technol. Meeting, Brookhaven Natl. Lab., Upton, N. Y., May 17–18, 1962 p 276–285 (See N63-15001 11-13) OTS: $5.00

Work in the initial phases of a multiphase program on the condensation of alkali metals is discussed. Data are presented on overall heat-transfer coefficients and individual (metal film) coefficients for sodium and rubidium. Results indicate that the classical Nusselt equation does not adequately describe alkali metal condensation. In general, there is still a need for additional work on analytical solutions of the boundary phenomena as well as for additional refinements in experimental determinations. I.v.L.

N63-15019 Sundstrand Aviation-Denver, Denver, Colo.

RUBIDIUM HEAT TRANSFER TESTING AT SUNDSTRAND AVIATION-DENVER

R. Loehrke *In* Brookhaven National Lab. Proc. of 1962 [Second Annual] High-Temp. Liquid-Metal Heat Transfer Technol. Meeting, Brookhaven Natl. Lab., Upton, N. Y., May 17–18, 1962 p 286–291 (See N63-15001 11-13) OTS: $5.00

A test loop for obtaining order-of-magnitude information concerning heat-transfer rate during the boiling of rubidium in a small diameter tube with net production of dry vapor is described. Data from tests thus far show high heat-transfer coefficients during the boiling of rubidium up to a quality of 70%. A rubidium condensing loop is being tested in the light of investigating the pressure drop and flow characteristics of the condenser. To date, only preliminary data have been obtained. I.v.L.

N63-15020 Atomics International, Canoga Park, Calif.

DEVELOPMENT OF SNAP 2 HEAT TRANSFER COMPONENTS

W. D. Leonard and R. D. Keen *In* Brookhaven National Lab. Proc. of 1962 [Second Annual] High-Temp. Liquid-Metal Heat Transfer Technol. Meeting, Brookhaven Natl. Lab., Upton, N. Y., May 17–18, 1962 p 294–325 (See N63-15001 11-13) OTS: $5.00

(Contract AT(11-1)-GEN-8)

A review of the development of SNAP 2 components includes the (1) expansion compensator, (2) parasitic load heater, (3) flow trimmer, (4) orbital start pump, (5) radiator-condenser, and (6) auxiliary ground heater. The purposes of these components in the same sequential order are: (1) the absorption of the NaK volume increase due to thermal expansion and the regulation of the NaK pressure to ensure that at no time boiling occurs in the reactor; (2) the absorption of the power generated by the alternator over and above the immediate demands of the payload; (3) the provision of a means for adjusting the NaK flow and temperature; (4) the circulation of NaK at 5% of the design flow prior to the spin-up of the combined rotating unit; (5) the condensation of the vapor from the turbine and the subcooling of the liquid so that, as the mercury from the radiator-condenser is mixed with the high-temperature bearing drain fluid and fed to the pump, the maximum inlet temperature will not be exceeded; and (6) the simulation of the reactor power (53kw). I.v.L.

N63-15021 Martin Co. Nuclear Div., Baltimore, Md.

DESIGN AND FABRICATION OF A 2100°F FORCED CONVECTION LITHIUM TEST LOOP

Ivan L. Gray *In* Brookhaven National Lab. Proc. of 1962 [Second Annual] High-Temp. Liquid-Metal Heat Transfer Technol. Meeting, Brookhaven Natl. Lab., Upton, N.Y., May 17–18, 1962 p 326–352 (See N63-15001 11-13) OTS: $5.00

This paper is a progress report on the design, fabrication, and installation of a one-inch diameter, columbium-alloy, forced convection loop that is rated at a temperature of 2100° F and flow of 20 gpm lithium. The overall system is briefly described, and emphasis is placed on the resolution of problems that arose during the design and fabrication stages. Photographs taken during the loop assembly are presented. Author

N63-15022 Geoscience Ltd., La Jolla, Calif.

HIGH-TEMPERATURE LIQUID-METAL HEAT TRANSFER FOR THE AEC Progress Report

H. F. Poppendiek and N. D. Greene *In* Brookhaven National Lab. Proc. of 1962 [Second Annual] High-Temp. Liquid-Metal Heat Transfer Technol. Meeting, Brookhaven Natl. Lab., Upton, N. Y., May 17–18, 1962 p 353–379 22 refs (See N63-15001 11-13) OTS: $5.00

This report presents the results of: (1) a review and summary of past liquid-metal heat and momentum transfer research; (2) analytical two-phase flow, heat transfer, and thermodynamic properties studies; (3) preliminary mercury heat transfer system design studies; and (4) experimental two-phase flow momentum transfer studies. The past research included nonboiling heat and momentum transfer and film and nucleate-pool boiling. The analytical work included separated two-phase flows, vortex decay, free-convection film boiling, forced-convection film boiling, Mollier diagrams, and physical properties. Experimental two-phase flow pressure drop data on air-water flows in a helical passage were obtained and compared with predicted values. I.v.L.

N63-15023 Argonne National Lab., Ill.

BOILING SODIUM EXPERIMENTAL STUDIES

J. B. Heineman and J. F. Marchaterre *In* Brookhaven National Lab. Proc. of 1962 [Second Annual] High-Temp. Liquid-Metal Heat Transfer Technol. Meeting, Brookhaven Natl. Lab., Upton, N. Y., May 17–18, 1962 p 380–385 3 refs (See N63-15001 11-13) OTS: $5.00

Since liquid metals are especially adapted to electromagnetic pumping and generation, it was deemed feasible to investigate the possibility that the signal output of an electromagnetic flowmeter will remain a linear function of the liquid velocity up to a high value of void fraction. To test the feasibility of this assumption before attempting its application in the boiling sodium experiment, a two-phase, two-component loop was operated using NaK and argon. Two e.m. flowmeters were calibrated with the aid of the orifice and manometer system after wetting was accomplished by continuous running at 350° F for approximately 50 hours. Argon was injected at various flow rates to cover a range of quality from 0.0006 to 0.003. The void fraction for each run was calculated by three different methods as follows: attenuation, Froude number correlation, and measured (e.m. flowmeter). The attenuation results are high at void fractions greater than 20%. This is because of the inherent error of the "one shot" method. The general results and the simplicity of this method appear to warrant its use; however, there are some disadvantages. If permanent magnets are used, they must be continuously cooled well below the Curie point. Also, the flowmeter "constant" is not really a constant, since it will vary with the temperature change which is due mostly to decreased magnet strength. There is also a correction factor for the wall shunting effect, as derived by Elrod and Fouse. This effect actually varies with void fraction and liquid velocity distribution. I.v.L.

N63-15024 Brookhaven National Lab., Upton, N.Y.
EDDY DIFFUSIVITY EFFECT IN LIQUID-METAL HEAT TRANSFER
O. E. Dwyer *In its* Proc. of 1962 [Second Annual] High-Temp. Liquid-Metal Heat Transfer Technol. Meeting, Brookhaven Natl. Lab., Upton, N.Y., May 17–18, 1962 p386–398 16 refs (See N63-15001 11-13) OTS: $5.00
(Work performed for AEC)
(BNL-6149)

Equations are presented for calculating the heat transfer for liquid metals under the following conditions: (1) flow in circular pipes, (2) flow in concentric annuli, (3) in-line flow through rod bundles. I.v.L.

N63-15051 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
AN EXPERIMENTAL STUDY OF THE BEHAVIOR OF SPHERES ABLATING UNDER CONSTANT AERODYNAMIC CONDITIONS
Robert R. Howell Washington, NASA, Apr. 1963 16 p 4 refs
(NASA TN D-1635) OTS: $0.50

Five spheres constructed of ablative material, with diameters of 0.6 inch to 2.0 inches, were subjected to aerodynamic heating to determine the physical behavior of such bodies as they are reduced toward zero volume by the ablation process. Three of the bodies were tested in hypersonic flow, one was tested in supersonic flow, and one was tested in subsonic flow. The stagnation-point heating rate for the tests varied between 52 and 565 Btu/(sq ft)(sec). The Reynolds number based on model diameter varied between 1.0×10^4 and 9.6×10^4. Results indicate that the recession rate of the stagnation point is essentially constant over the life span of such bodies, regardless of the magnitude and character of the convective heating imposed. There was an apparent tendency for the average radius of the ablating face to increase slightly with time at supersonic and hypersonic speeds and to decrease with time at the subsonic speed. In the supersonic tests, no noticeable loss of material occurred over the downstream surface of the bodies. In the subsonic test, however, loss on the downstream surface equaled that over the forward surface. A discussion of the measured recession rate of the stagnation point is presented. Author

N63-15063 Chance Vought Corp. Aeronautics and Missiles Div., Dallas, Tex.
HEAT-TRANSFER-RATE MEASUREMENT USING A THIN-CONTINUOUS-SKIN TECHNIQUE IN A HYPERVELOCITY WIND TUNNEL
J. L. Lindsey Feb. 20, 1963 52 p 10 refs
(Rept. 2-59740/3R445)

A test program was conducted at the Chance Vought Hypervelocity Wind Tunnel to establish the feasibility of using a thermocouple-equipped, thin-continuous-skin model as a device for measuring heat-transfer rates in a hypervelocity wind tunnel. Comparison of data obtained using a hemisphere-cylinder model with theory and with data from other facilities demonstrates that the thin-continuous-skin technique is a valid method of measuring heating rates. Author

N63-15102 Oklahoma U. Research Inst., Norman
AN INVESTIGATION OF RADIANT HEAT TRANSFER IN ABSORBING, EMITTING AND SCATTERING MEDIA
Tom J. Love, Jr. Wright-Patterson AFB, Ohio, Aeronautical Research Labs., Jan. 1963 311 p 38 refs
(Contract AF 33(657)-8859)
(ARL 63-3)

This is a study designed to examine the effect of anisotropic scattering on radiant heat transfer. The following problems are considered: (1) radiant heat transfer between a diffuse plane wall and an isothermal, scattering, absorbing, and emitting media of infinite extent; (2) radiant heat transfer between two diffusely reflecting and emitting plane walls and an isothermal separating medium which scatters, absorbs, and emits radiant energy; (3) radiant heat transfer between two plane walls separated by an absorbing, emitting, and scattering medium in radiative equilibrium; and (4) radiant heat transfer to a diffuse surface bounding one side of an absorbing and scattering medium of finite optical thickness with a uniform parallel flux incident in a normal direction on the "free surface" of the medium. Results are presented for scattering by spheres composed of material having refractive indices of 1.25 to 1.25 and 2.00 to 0.60, corresponding roughly to iron and carbon, respectively, and the case of isotropic scattering. The results include the effect of variations of surface reflectivity, optical spacing, and particle size to wavelength ratio. Author

14 HUMAN BEHAVIOR

Includes: crew training and evaluation; piloting; psychological factors.

For simulators see: 10 Facilities.
For related information see: 16 Life Sciences.

N63-15180 Aerospace Medical Div. Aerospace Medical Research Labs. (6570th), Wright-Patterson AFB, Ohio
A COMPARISON BETWEEN TRACKING WITH "OPTIMUM" DYNAMICS AND TRACKING WITH A SIMPLE VELOCITY CONTROL [Final Report]
George G. Frost Dec. 1962 19 p 4 refs
(AMRL-TDR-62-150) OTS: $0.75

This study was undertaken to verify the "optimum" control dynamics reported in WADC TR 59-712 and to lend experimental validation to the method in which they were derived. A simple two-group experiment was performed to compare tracking performance on a single-axis task using the "optimum" dynamics, with tracking performance using a simple integrator (rate control). No significant difference was found in either learning rate or in tracking ability after the task was learned. A second experiment using the same experimental design requiring two-axis tracking was conducted to test the hypothesis that differences would appear only when the subjects were more heavily task-loaded. The "optimum" dynamics produced reliably better performance than the rate control in the two-axis task. Author

N63-15241 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
A SIMPLIFIED METHOD FOR MEASURING HUMAN TRANSFER FUNCTIONS
James J. Adams Apr. 1963 37 p 10 refs
(NASA TN D-1782) OTS: $1.00

An investigation has been made with a nonmoving simulator to determine the effectiveness of a simplified method of measuring human transfer functions. The method is based on an adaptive autopilot scheme. In this method an analog pilot, which contains three variable gains, is automatically adjusted to match the human pilot. The gains are adjusted so as to minimize the root-mean-square difference between the analog pilot and the human pilot. The dynamics that the pilot controlled were varied. The tests demonstrated that stable determination of the transfer-function gains could be achieved. Tests in which the adjustable analog pilot was required to match a fixed-gain analog pilot resulted in accurate determination of the gains. Tests made with human subjects

resulted in gains which are in general agreement with previous studies, in that the lead of the pilot is increased as the lag of the controlled dynamics is increased. Author

15 INSTRUMENTATION

Includes: design, installation, and testing of instrumentation systems; gyroscopes; measuring instruments and gauges; and sensors and transducers.

For related information see: 06 Auxiliary Systems; 08 Communications; 09 Electronics; and 22 Navigation and Guidance.

N63-14732 Naval Research Lab., Washington, D.C.
A METHOD FOR THE ESTABLISHMENT OF THE QUICKENING TERMS FOR AN IMPROVED BINARY ANGLE OF ATTACK DISPLAY [Interim Report]
Alan W. Baldwin, Barbour Lee Perry, Ruth H. Shields, and Henry P. Birmingham July 17, 1962 14 p 3 refs
(NRL-5778)

This study investigates the development of a quickening term for the stabilization of high-order systems through the use of mathematical analysis together with analog computer simulation of the system dynamics and the design of appropriate circuitry modification. This method was developed at NRL to facilitate the design of an improved binary-type light display used in jet aircraft to indicate a "too high" or "too low" angle-of-attack condition. The mathematical analysis was effected through the use of Laplacian transform theory by means of which a synthesized simulation, structurally unlike but mathematically equivalent to the original simulation can be developed. The simplified configuration of this synthesized simulation facilitates the determination of the proper quickening needed to stabilize both the synthesized and the original simulation. Results of the test evaluation of the improved simulation show an increase in accuracy of almost four to one compared with the performance with a conventional display. Author

N63-14769 Aro, Inc., Arnold Air Force Station, Tenn.
CALIBRATION OF THE AEDC-PWT 1-FT SUPERSONIC MODEL TUNNEL AT MACH NUMBERS 1.5 to 4.5
J. R. Herson and E. H. Sloan Arnold Engineering Development Center, Mar. 1963 34 p 4 refs
(Contract AF 40(600)-1000)
(AEDC-TDR-63-47)

A test program was conducted to calibrate the test region of the PWT 1-Ft Supersonic Model Tunnel. Theoretical nozzle contours were corrected utilizing the influence method. Results of the calibration at nominal Mach numbers from 1.5 to 4.5, in quarter Mach number increments, are presented along with boundary-layer data. The maximum Mach-number variation was ±0.5 percent along the axis of the semiflexible nozzle and ±0.85 percent along the axis of the test region for all Mach numbers. Author

N63-14773 Air Force Special Weapons Center, Kirtland AFB, N. Mex.
FIELD SHIFT IN HIGH-SPEED ROTATING MIRROR FRAMING CAMERAS
D. C. Wunsch and A. H. Guenther Sept. 1962 23 p
(AFSWC-TDR-61-76)

High-speed framing cameras, which make use of rotating mirrors acting as field stops, exhibit a changing field of view and frame size as the mirror rotates. The use of the frame edge as a reference line in data analysis from the film requires that the magnitude of these effects be known. A discussion of these effects and calculations of their magnitude for a Beckman and Whitley model 189 framing camera are given. Author

N63-14780 Aro, Inc., Arnold Air Force Station, Tenn.
CALIBRATION OF THE 100-INCH HYPERVELOCITY TUNNEL (F)
Henry W. Ball Arnold Engineering Development Center, Mar. 1963 35 p 15 refs
(Contract AF 40(600)-1000)
(AEDC-TDR-63-46)

A test program was conducted to calibrate the von Kármán Gas Dynamics Facility's 100-Inch Hypervelocity Tunnel (F). Pitot pressure profiles were measured at four test conditions defining a test regime between Mach numbers 18 and 21 and Reynolds numbers between 30,000 and 300,000 per foot. At a median test condition more extensive tests were made to obtain the axial Mach number gradient, local flow angles, and the repeatability of aerodynamic measurements on a group of blunted 9-deg cone models. In the range of test conditions investigated, the diameter of the useable test core varied from 30 to 40 in. Source flow effects on the surface pressures on radially spaced slender cones resulted in 73 percent of the theoretically predicted effects and an axial Mach number gradient of 0.1 per foot. The force and heat-transfer rate measurements on the cone models agreed with theory and data from other tunnels within ±10 percent. These aerodynamic data and the results from a heat-transfer rate contamination monitor showed no significant effects caused by possible pressure of particles in the flow. Author

N63-14785 Naval Research Lab., Washington, D.C.
INTERCALIBRATION OF SOME SYSTEMS EMPLOYED IN MONITORING FISSION PRODUCTS IN THE ATMOSPHERE
L. B. Lockhart, Jr. and R. L. Patterson, Jr. Nov. 13, 1962 25 p 5 refs
(NRL-5820)

A study has been made of some of the systems involved in measuring the concentrations of fission products in the air at ground level, and a direct comparison made of radioactivity results reported from each of the systems on replicate samples, made at the same time and place, over an extended period. Some information on the filtration characteristics of the various filter media is also included. The experimentally determined relative radioactivity concentrations of identical air samples from which interconversion factors can be derived for directly comparing any of the systems with another are as follows: NRL air monitor, 1.00; U.S. Public Health Service Radiation Surveillance Network, 1.17; Canadian Air Monitoring Network, 1.82; NRL 80th Meridian Network, 2.07. These ratios are based on the sampling of a known volume of air; there is presently some degree of uncertainty as to the actual volume of air sampled at the various field sites of the three operating networks. Author

N63-14845 National Bureau of Standards, Washington, D.C.
BIBLIOGRAPHY AND INDEX ON VACUUM AND LOW PRESSURE MEASUREMENT
W. G. Brombacher Nov. 10, 1961 108 p 1538 refs
(NBS-Monograph-35) GPO: $0.60

The bibliography contains 1538 references, of which 52 are on books. About 550 of the periodical references are specifically on pressure measurement, including both vacuum gages and micromanometers. The balance are on vacuum technology, including adsorption, degassing, vacuum pumps, controlled gas leaks, valves, seals, and vacuum systems, all of which bear on the technique

of vacuum measurement. The indices consist of an author index and an index of the subject matter of the listed references. Author

N63-14900 Aerojet-General Corp. Ordnance Div., Downey, Calif.

ORDNANCE SYSTEM AND COMPONENT DESIGN CONSIDERATIONS IN ACHIEVING 1-AMP/1-WATT NO-FIRE CHARACTERISTICS Technical Memorandum

C. M. Hall Mar. 28, 1962 25 p 1 ref

(N-106-210)

The available electroexplosive devices (EED's) are discussed to point out the areas that must be considered in the development of EED's which satisfy the 1 amp/1 watt no-fire requirement. Both the hot bridgewire and the exploding bridgewire EED systems are covered. It is concluded that the production of EED's to meet these requirements is well within the present state-of-the-art. R.C.M.

N63-14942 Columbia U. School of Engineering and Applied Science, New York, N.Y.

RADIATION MEASUREMENTS AND ENERGY CONVERSION

M. Mitchner and R. A. Gross Aug. 1962 128 p refs

(NSF Grant 17701)

Theory, experimental apparatus, and experimental results are described for radiation measurements from the ultraviolet to the infrared (2000 Å to 14,000 Å), and energy conversion using semiconductor solar cells. This work is part of the National Science Foundation new laboratory-equipment-development project to improve laboratory demonstration experiments. Author

N63-14946 Little (Arthur D.), Inc., Cambridge, Mass.

INVESTIGATION OF THE THERMAL PROPERTIES OF HIGH-TEMPERATURE INSULATION MATERIALS Second Quarterly Progress Report

Nov. 15, 1962 81 p refs

(Contract AF 33(657)-9172)

(C-64694)

Included is a summary of the method of manufacture; physical, chemical, and mechanical properties; and the cost and availability of prospective components for high-temperature insulation systems. Progress in the experimental and theoretical investigation of the contributions of solid conduction and radiation to thermal conductivity is discussed. Data on the effective thermal conductivity of graphite fibers are reported and an estimate of the precision of measurement is given. Author

N63-14947 Brookhaven National Lab., Upton, N.Y.

EXPERIMENTAL PROGRAM REQUIREMENTS FOR A 300 TO 1000-BEV ACCELERATOR AND DESIGN STUDY FOR A 300 TO 1000-BEV ACCELERATOR

Luke C. L. Yuan and John P. Blewett, eds. Mar. 1963 (Rev.) 174 p 190 refs

(Sponsored by AEC)

(BNL 772(T-290)) OTS: $2.75

CONTENTS:

1. EXPERIMENTAL PROGRAM REQUIREMENTS FOR A 300 TO 1000-BEV ACCELERATOR Luke C. L. Yuan p 3-104 109 refs (See N63-14948 11-15)
2. DESIGN STUDY FOR A 300 TO 1000-BEV ACCELERATOR John P. Blewett p 107-169 81 refs (See N63-14949 11-15)

N63-14948 Brookhaven National Lab., Upton, N.Y.

EXPERIMENTAL PROGRAM REQUIREMENTS FOR A 300 TO 1000-BEV ACCELERATOR

Luke C. L. Yuan, ed. *In its* Experimental Program Requirements for a 300 to 1000-Bev Accelerator and Design Study for a 300 to 1000-Bev Accelerator Mar. 1963 (Rev.) p 3-104 109 refs (See N63-14947 11-15) OTS: $2.75

An outline of the program requirements for a 300 to 1000 nuclear accelerator is presented along with a bibliography of the contributors to the program. The main objectives are: (1) to evaluate the desirability for such an accelerator; (2) to analyze various known detection and particle separation techniques so their usefulness at high energies can be ascertained; (3) to find new detection and separation techniques applicable at high energy levels; (4) to estimate the beam kinetics and properties of secondaries produced in targets; (5) to design the experimental area and the shielding needed for such a machine; (6) to consider some specific experiments of interest. D.E.R.

N63-14949 Brookhaven National Lab., Upton, N.Y.

DESIGN STUDY FOR A 300 TO 1000-BEV ACCELERATOR

John P. Blewett, ed. *In its* Experimental Program Requirements for a 300 to 1000-Bev Accelerator and Design Study for a 300 to 1000-Bev Accelerator Mar. 1963 (Rev.) p 107-169 81 refs (See N63-14947 11-15) OTS: $2.75

The feasibility and design of an accelerator to deliver particles with energies above 300 bev is discussed. The upper limit of 1000 bev is only arbitrary because it is dependent on manpower and money. The principles used are the same as those of the Brookhaven alternating gradient synchrotron or the CERN proton synchrotron, extended to higher energy levels. A bibliography of work done at several centers is annotated. D.E.R.

N63-14970 Atomics International, Canoga Park, Calif.

A METHOD FOR DIFFERENTIATING BETWEEN MATERIALS CONTAINING NORMAL AND FULLY ENRICHED URANIUM

R. C. Barry and A. R. Mooers Apr. 15, 1963 18 p

(Contract AT(11-1)-GEN-8)

(NAA-SR-7752) OTS: $0.50

When normal uranium and fully enriched uranium are used in the same research, development, or manufacturing area, the possibility always exists that chips, shavings, scrap, fuel rods, and even fuel elements may not be properly identified or may lose their identity. A system has been developed which will allow rapid determination of whether uranium-zirconium alloys or unalloyed uranium metal contain either normal or fully enriched uranium. This autoradiometric system is based on the fact that the U^{238} decay chain includes the emission of a 2.31-Mev beta particle, which is more easily absorbed by an aluminum filter than gamma photons emitted during the decay of U^{235}. The instrumentation required and the procedures employed for the identification of normal or fully enriched uranium-zirconium alloys or unalloyed uranium metal are described. The procedures described should be readily adaptable to other uranium-bearing compounds and alloys. Author

N63-14973 National Aeronautics and Space Administration, Washington, D.C.

ITALIAN SATELLITE INSTRUMENTS TESTED IN WALLOPS ROCKET FLIGHT News Release No. 63-76

[1963] 4 p

Available from NASA. Office of Scientific and Technical Information, Wash., D. C.

A preliminary instrumentation test, which will be used in the joint Italian-U. S. San Marco project, was made aboard a Shotput sounding rocket, according to NASA. The test is designed to measure the total atmospheric drag upon a satellite during orbital flight. A.R.B.

N63-14978 Pennsylvania State U. Ionosphere Research Lab., University Park

AN IMPROVED LOW FREQUENCY SWEEP POLARIMETER

S. Weisbrod and A. J. Ferraro Apr. 1, 1963 35 p 3 refs

(Contract AF 19(604)-8012)

(Sci. Rept. (E)-182; AFCRL-63-290)

This report describes an improved version of a low-frequency polarimeter which is used in conjunction with the low-frequency sweep studies at the Ionosphere Research Laboratory. The purpose of this equipment is to resolve signals received from horizontal cross-polarized dipoles into signals which are proportional to the sum and difference of the ordinary and the extraordinary magneto-ionic components over the frequency range of 80 to 1200 kc. In the construction of this equipment, emphasis has been placed on sensitivity, stability, elimination of spurious coupling between channels, and the ease of routine calibration and adjustment. Author

N63-15036 Martin Co., Baltimore, Md.

SNAP 7D. STRONTIUM-90 FUELED THERMOELECTRIC GENERATOR POWER SOURCE THIRTY-WATT U. S. NAVY FLOATING WEATHER STATION Final Report

C. N. Young Mar. 15, 1963 93 p 16 refs

(Contract AT(30-3)-217)

(MND-P-2835) OTS: $2.25

The objectives of the SNAP 7D program were to design, manufacture, test, and deliver a thirty-watt electric generating system for a modified U. S. Navy NOMAD-class weather buoy to be stationed in the Gulf of Mexico. This report describes the sixty-watt strontium-90 thermoelectric generator, the relay panel, the batteries, and the installation of the system in a boat-type buoy. The electrical tests of the generator and of the system, the shock and vibration tests, and the tests at the environmental temperature extremes are discussed in detail. Author

N63-15053 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

PORTABLE INTEGRATING SPHERE FOR MONITORING REFLECTANCE OF SPACECRAFT COATINGS

F. A. Jerozal (Continental Technical Service, Inc.), W. B. Fussell, and J. J. Triolo Washington, NASA, Apr. 1963 15 p 7 refs Previously announced as a preprint, see N62-17073 18-15

(NASA TN D-1714)

An integrating sphere is the most convenient device for measuring the total reflectance of opaque coatings of different degrees of curvature, specularity, and diffusivity. A portable, 8-lb, single-beam, 6-inch-diameter integrating sphere reflectometer has been designed and fabricated at the GSFC, and has been used extensively to detect changes in the solar absorptivity of spacecraft coatings due to environmental testing, ageing, or contamination. Author

N63-15058 Warner and Swasey Co. Control Instrument Div., Flushing, N. Y.

MEASUREMENT OF TEMPERATURE IN GASEOUS DETONATIONS BY MONOCHROMATIC RADIATION PYROMETRY

Gunter J. Penzias and Richard H. Tourin Oct. 1962 25 p 10 refs

(Contract AF 33(616)-8319)

The infrared monochromatic radiation (IMRA) method of gas temperature measurement was applied to determination of temperature in gaseous detonations. A detonation tube facility was constructed in which the infrared spectral emittance and absorptance of a detonation wave could be measured through infrared-transparent windows. A high-speed infrared monochromatic pyrometer, which has time resolution of better than 10 microseconds, was used to make the temperature measurements. For hydrogen-oxygen, propane-oxygen, and propane-oxygen-nitrogen mixtures, initially at one atmosphere pressure, the measured temperatures agreed with theoretical values calculated on the basis of the Chapman-Jouget theory. The measured temperature was independent of spectral wavelength, demonstrating that the temperature profile across the detonation tube was uniform. Author

N63-15092 California U., Livermore. Lawrence Radiation Lab.

A CONTROLLED-POTENTIAL COULOMETER

F. B. Stephens and J. E. Harrar Jan. 21, 1963 17 p 7 refs

(Contract W-7405-eng-48)

(UCRL-7165) OTS: $0.50

A controlled-potential coulometer has been developed for routine use which combines a previously designed solid-state potentiostat with a vacuum-tube integrator circuit. The instrument features a simple, direct readout circuit which permits visual presentation on a digital voltmeter of the amount in milligrams of substance reduced or oxidized. Circuit operation, calibration procedure, and use in analyses are described. Performance in analysis of uranium and hydrogen peroxide is presented. Author

N63-15196 Air Proving Ground Center, Eglin AFB, Fla.

EVALUATION OF THE MODIFIED MATTS [Final Report]

John F. Kantak Mar. 1962 75 p 3 refs

(APGC-TDR-62-14)

The purpose of this test was to evaluate the capability of the modified MATTS to achieve, at minimum, premodification accuracies. Three MATTS configured aircraft were utilized to simulate the vehicles involved in the MATTS measurement of a typical intercept. Data were collected on pertinent flight paths within the MATTS operational envelope. Tracking accuracy is satisfactory or acceptable throughout the tested profile except at the extreme western end of the SAGE drone track, where the errors are too large for MATTS application. Spatial position accuracies are comparable to those obtained from the original MATTS. Scoring accuracy meets the required accuracies for miss and escape-distance calculations within the testing area flown to assess these accuracies, with the following exceptions: the extreme western end of the SAGE drone track, the south leg of the SAGE drone track, and the 60 and 80 NM legs parallel to the Y base line over the firing range. Author

16 LIFE SCIENCES

Includes: biology; exobiology; physiology; medicine; life support systems; radiation effects on biological systems; and space sickness.

For related information see: 14 Human Behavior; and 28 Space Radiation.

N63-14733 Naval Research Lab., Washington, D.C.

NUCLEAR SUBMARINE ATMOSPHERES—ANALYSIS AND REMOVAL OF ORGANIC CONTAMINANTS [Interim Report]

J. E. Johnson Sept. 10, 1962 12 p 19 refs

(NRL-5800) OTS: $0.50

This Laboratory has carried out a program of sampling and analysis of the atmospheres of nuclear submarines for the identification and estimation of organic contaminants. Most of these organic compounds have been found to be hydrocarbons. The total hydrocarbon content of submarine atmospheres was initially very high (100 to 200 mg/m^3) but has decreased to very low values in many cases (<10 mg/m^3) by means of careful control measures. Individual aromatic hydrocarbons have been isolated with an estimation of their concentrations. The principal sampling method is

based on the exposure of activated carbon on shipboard followed by desorption of the carbon in the laboratory. The most useful means of removing organic contaminants from the submarine atmospheres are combustion by means of a catalyst and adsorption by activated carbon contained in large filter beds. Calculations of the effectiveness of these measures under various conditions of use were made based on typical analytical data. Author

N63-14789 Aerospace Medical Center. School of Aerospace Medicine, Brooks AFB, Tex.

EFFECTS OF ACUTE RADIATION EXPOSURE ON HUMAN PERFORMANCE

Robert B. Payne Feb. 1963 29 p 55 refs Presented at the Gatlinburg Symposium on Protection Against Radiation Hazards in Space, Nov. 6, 1962

(/ts Aeromedical Review 3-63)

Studies of anthropoid behavior observed under various kinds, rates, and amounts of ionizing radiation have shown that behavioral functions are highly resistant to acute doses of radiation. This fact holds true for those doses well above the level required to produce acute radiation sickness. But behavior is not impregnable to acute radiation, and further research is necessary to relate this aspect to the radiation dimensions and to the damage produced in tissues. Therefore, any exposure intense enough to produce physiological change should be regarded as behaviorally important, since it imposes constraints upon the convenience with which the individual can adapt to environmental circumstances. D.E.R.

N63-14790 Aerospace Medicine Center. School of Aerospace Medicine, Brooks AFB, Tex.

BACKWARD MASKING: MONOTIC AND DICHOTIC CONDITIONS

Lois L. Elliott June 1962 18 p 21 refs

(SAM-TDR-62-76)

"Backward masking" is the term used to denote the situation in which one auditory stimulus is masked by another auditory stimulus which follows it in time, while in "forward masking" the temporal positions of masking and masked signals are reversed. In this study, backward and forward masking were investigated for both monotic and dichotic conditions by using white noise as the masking signal and a 1000-cps probe signal. Results indicate that monotic backward masking occurs over intervals up to 50 msec.; while for the dichotic condition, backward masking occurs for intervals as long as 15 msec. Less monotic forward masking is obtained for brief masking intervals, and very little dichotic forward masking is observed. These findings are considered in relation to other experimental results. Author

N63-14791 Institute of Andean Biology, Lima (Peru)

PYRIDINE NUCLEOTIDE OXIDASES AND TRANSHYDROGENASE IN ACCLIMATIZATION TO HIGH ALTITUDE

Baltazar Reynafarje Brooks AFB, Tex., USAF School of Aerospace Med., Nov. 1962 10 p 7 refs

(Contract AF 41(657)-249)

(SAM-TDR-62-88)

Activity of pyridine nucleotide oxidases and transhydrogenase has been examined in heart, liver, and rectus femoris muscle of guinea pigs native of sea level and high altitude. There was an enhanced, reduced form of diphosphopyridine nucleotide oxidase (DPNH-oxidase) and transhydrogenase activity in heart and muscle from animals adapted to high altitude. The higher activity in muscle at altitude was due solely to increase in ratio of red to white portions. Both groups showed the pigmented portion twice as active as the white one. In liver, neither the DPNH-oxidase system nor the transhydrogenase was significantly changed in their activity on a fresh-weight basis. Nevertheless, the DPNH-oxidase is higher at altitude when the activity is expressed per gram of nitrogen. The reduced form of triphosphopyridine nucleotide oxidase activity was not appreciably changed in any of the tissues. It was concluded that adaptation to high altitude is associated with apparent changes in the magnitude of the electron transport pathway. Increased activity in skeletal muscle is probably related to the tissue pigment content. Author

N63-14823 California U., Berkeley. Electronics Research Lab.

THE DIELECTRIC PROPERTIES OF WATER AND THEIR ROLE IN ENZYME-SUBSTRATE INTERACTIONS

P. O. Vogelhut Aug. 24, 1962 119 p 68 refs

(Contract Nonr-222(92))

(IER Ser. 60, Issue 476)

The structures of water, aqueous solutions, and ice are briefly reviewed, primarily with regard to their electrical characteristics. A new model of water is proposed, based on the concept of double-bond and vacant-bond orientational defects, and is used for the computation of the frequency and temperature dependence of pure and contaminated water (solutions). A new cavity-perturbation measurement technique is used to obtain the dielectric constant of water and of aqueous solutions at microwave frequencies. The results agree well with our model of water and its solutions, and are accurate enough to permit continuous measurements of changes of the dielectric constant of enzyme-substrate mixtures as a function of time after mixing. The data are interpreted on the basis of our new model of water (the concepts of defect and excess protons as charge carriers) and the analogy with catalytic properties of surfaces of electronic semiconductors; water bound to the surface of the enzyme molecule (itself constituting a surface) strongly suggests a protonic semiconductor. The energy levels of the water surface are modified by the presence of residues on the enzyme molecule, and may be conveniently expressed by circuit diagrams similar to those used in integrated solid-state circuits. The postulated circuit is a tunnel-diode oscillator, tuned to the characteristic frequency of the substrate molecule, which it attracts and whose bond it breaks by positive feedback. Author

N63-14824 Naval Radiological Defense Lab., San Francisco, Calif.

GROSS DENTAL LESIONS IN THE RAT INDUCED BY X RAYS AND NEUTRONS

T. J. Castanera, D. C. Jones, and D. J. Kimeldorf Feb. 13, 1963 23 p 10 refs

(USNRDL-TR-620)

Male Sprague-Dawley rats were exposed at 101 days of age to whole-body doses of 430 or 680 rads of X-rays, or to 230, 320, or 360 rads of fast neutrons. Dental lesions, evidenced by chalky white zones in the tooth substance, began appearing at the gingival crest at approximately 35 days postirradiation in the mandibular incisors and several weeks later in the maxillary incisors. The time of maximum incidence of animals with lesions occurred between the fiftieth and seventy-fifth days postirradiation and, by the end of the fourth month, all lesions had disappeared from the continually growing incisors through attrition at the occlusal edges. The total incidence of animals with one or more lesions was 97% after 430 rads of X-ray and 100% after all other doses. The size of the lesions and the number of lesions per animal were greater at the higher doses for each type of radiation. In some animals, fractures occurred at the lesion and were confined largely to mandibular incisors. The total incidence of animals with fractured incisors was greater at the higher doses for each type of radiation. Food in meal form, presented in open containers, resulted in a lower incidence of fractures as compared with the results of a previous study in which the same food in pellet form was supplied in wire-mesh containers. Neutrons appeared to be two to three times more effective than X-rays in producing the lesions. Author

N63-14849 Miami U. School of Medicine, Coral Gables, Fla.
CHRONIC EXPOSURE OF DOGS TO MICROWAVE RADIATION OF 24,000 MEGACYCLES AND A POWER DENSITY OF 20 mw/cm^2
William B. Deichmann, Ernesto Bernal, Frank Stephens, and Karin Landeen Griffiss AFB, N. Y., Rome Air Development Center, May 1963 31 p 1 ref
(RADC-TDR-62-604)

Two female beagles were exposed to nearly total body radiation; one being exposed for a total of 2631 hours and the other being exposed for a total of 3970 hours. During these exposures, the dogs showed no signs of radiation effects: no eye abnormalities were produced; both dogs reproduced normally; and rectal temperatures, blood volume, hematocrit, hemoglobin, erythrocytes, total and differential leukocytes, blood cholesterol, and protein bound iodine values showed no significant changes from normal. Gain in body weight was subnormal in both animals. A.R.B.

N63-14887 Naval Radiological Defense Lab., San Francisco, Calif.
THE RELATIVE EFFECT OF PULSED RADIATION EXPOSURE IN PRODUCTION OF ACUTE MORTALITY IN MICE
E. J. Ainsworth, G. F. Leong, E. L. Alpen, and K. Kendall Mar. 8, 1963 14 p 14 refs
(USNRDL-TR-627)

Mice have been subjected to pulsed exposures of either fission spectrum neutrons or gamma radiation produced by a Triga Mark F reactor. The acute mortality response of animals given pulsed radiation of the order of 10^6 rads/min has been compared with mortality responses obtained by neutron irradiation at 40 rads/min and gamma irradiation at 100 rads/min. No significant differences in $LD_{30/30}$ were observed as a function of dose rate with either gamma or neutron irradiation. Author

N63-14922 California U., Berkeley
HEMODYNAMIC EVALUATION AT NULL GRAVITY
Nello Pace [Jan. 1962] 15 p 7 refs

The effect of chronic cancellation of the gravitational accelerative force on the blood circulatory system is discussed and evaluated. But it is found impossible to predict, in our present state of knowledge, the effect of removal of a constant environmental factor such as gravity, which must play an important role in determining the characteristics of the blood circulatory system. Examples are given of animal endurance in space probes and the return of men from orbit. However, attention is drawn to cardiac deterioration and functional anomaly in other experiments such as in high-speed aircraft, centrifuges, and space studies. D.E.R.

N63-14926 Naval Research Lab., Washington, D.C.
THE PRESENT STATUS OF CHEMICAL RESEARCH IN ATMOSPHERE PURIFICATION AND CONTROL ON NUCLEAR-POWERED SUBMARINES Second Annual Progress Report [1961]
V. R. Platt and J. C. White, eds. Aug. 29, 1962 101 p 76 refs
(NRL-5814) OTS: $2.25

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N63-14927 Naval Research Lab., Washington, D.C.
SUMMARY OF PROGRESS
In its Present Status of Chemical Research in Atmosphere Purification and Control on Nuclear-Powered Submarines Aug. 29, 1962 p 1–7 12 refs (See N63-14926 11-16) OTS: $2.25

Emphasis is at present being placed almost exclusively upon atmospheres in nuclear-powered submarines. Considerable progress has been made in the major efforts to develop (a) the sulfate-cycle system for the electrolytic generation of oxygen from water and the absorption of carbon dioxide, (b) improved methods for producing chlorate candles and increasing their oxygen content (and output), and (c) improved methods of sampling and analyzing atmospheres. Other topics covered in the present report include the use of algae for oxygen production and carbon dioxide absorption, Freon and general-purpose leak detectors, properties of monoethanolamine (MEA), catalytic combustion studies using hopcalite, and removal of aerosols with electrostatic precipitators. Author

N63-14928 Naval Research Lab., Washington, D.C.
LABORATORY-SCALE OPERATION OF THE SULFATE CYCLE
A. L. Pitman and S. T. Gadomski *In its* Present Status of Chemical Research in Atmosphere Purification and Control on Nuclear-Powered Submarines Aug. 29, 1962 p 9–15 6 refs (See N63-14926 11-16) OTS: $2.25

A laboratory-size sulfate-cycle plant was designed, assembled, and operated in short run trials in an attempt to solve major problems in submarine air purification, i.e., the production of oxygen and the elimination of carbon dioxide. The sulfate cycle is based on the

electrolysis of an aqueous solution of sodium sulfate. This electrolysis yields: oxygen and hydrogen as gases with the latter compressed and pumped overboard; sodium hydroxide for absorbing the carbon dioxide, thus forming sodium carbonate; and sulfuric acid for neutralizing the sodium carbonate and excess sodium hydroxide, desorbing carbon dioxide to be compressed and pumped overboard, and for reforming sodium sulfate as liquids. Results indicate that: (1) Attempts to extend the life of the asbestos diaphragm at the anode by the use of Dacron cloth between the anode electrode and the asbestos caused an accelerated attack on the asbestos confined by the gasket. The cloth did not prevent the flaking or dissolution of asbestos in the remainder of the working area. (2) White asbestos, when used as an anode diaphragm, would probably fail in less than 100 hours of actual service, but it may still be useful as a cathode diaphragm. (3) The anolyte flow rates were relatively stable in a few runs in the larger electrolyzer with microporous rubber as an anode diaphragm. This is additional evidence for the belief that the rubber is a good answer to the anode diaphragm problem. The current efficiencies for oxygen with microporous rubber instead of asbestos are about the same. I.v.L.

N63-14929 Naval Research Lab., Washington, D.C.

DIAPHRAGMS FOR THE SULFATE-CYCLE ELECTROLYTIC CELL

J. A. Young, R. C. Clark, and K. D. Lawrence *In its* Present Status of Chemical Research in Atmosphere Purification and Control on Nuclear-Powered Submarines Aug. 29, 1962 p 16–20 1 ref (See N63-14926 11-16) OTS: $2.25

It has been shown from the laboratory studies using miniature electrolytic cells that microporous-rubber diaphragms meet all the stringent requirements of the sulfate-cycle electrolyzer, and are capable of giving service life measured in months. Author

N63-14930 Naval Research Lab., Washington, D.C.

ALGAE IN A PHOTOSYNTHETIC GAS EXCHANGER

P. J. Hannan, R. L. Shuler, and C. Patouillet *In its* Present Status of Chemical Research in Atmosphere Purification and Control on Nuclear-Powered Submarines Aug. 29, 1962 p 21–34 5 refs (See N63-14926 11-16) OTS: $2.25

The optimum light intensity for an algal gas exchanger system is investigated. Results indicate that the compact one-lamp unit is the most promising of any unit studied thus far for producing optimum light intensity. It is large enough (total algal suspension volume 1775 ml) to produce significant changes in the oxygen content of the gas stream, thereby permitting accurate determination of its productivity, yet it is a convenient size to operate. By constantly recording the carbon dioxide and oxygen concentrations of the effluent gas, a means of determining the photosynthetic capability of the unit is available, and changes in its performance may be detected almost immediately. This rapid detection of changes in the gas stream makes this type unit most convenient for quickly assaying various growth promoting additives. Based on the productivity of this one-lamp unit and on a daily requirement of 600 liters of oxygen per man, a volume of 75 liters of suspension would be sufficient to sustain a man. I.v.L.

N63-14931 Naval Research Lab., Washington, D.C.

CHLORATE CANDLES

J. K. Musick and P. R. Gustafson *In its* Present Status of Chemical Research in Atmosphere Purification and Control on Nuclear-Powered Submarines Aug. 29, 1962 p 35–43 5 refs (See N63-14926 11-16) OTS: $2.25

This review of sodium chlorate candles includes: (1) tests of a new candle composition consisting of 92% sodium chlorate, 4% barium peroxide, and 4% steel fibers; (2) glass blanket and water scrubber smoke filters for these candles; (3) the improvement of candle performance by a technique of hot pressing; and (4) the production of oxygen by the direct decomposition of sodium chlorate. I.v.L.

N63-14932 Naval Research Lab., Washington, D.C.

STUDIES ON MONOETHANOLAMINE (MEA)

H. Ravner and C. H. Blachly *In its* Present Status of Chemical Research in Atmosphere Purification and Control on Nuclear-Powered Submarines Aug. 29, 1962 p 45–50 7 refs (See N63-14926 11-16) OTS: $2.25

The degradation of monoethanolamine, which is used as the regenerative absorbent in carbon dioxide scrubbers, is reviewed in the light of understanding the mechanism of the stabilizing effect of the chelating agent Versene Fe-3 Specific. This chelating agent is the monosodium salt of N-diethanol glycine. I.v.L.

N63-14933 Naval Research Lab., Washington, D.C.

GAS CHROMATOGRAPHY AS A SUBMARINE ATMOSPHERE MONITOR

M. E. Umstead and H. W. Carhart *In its* Present Status of Chemical Research in Atmosphere Purification and Control of Nuclear-Powered Submarines Aug. 29, 1962 p 51–58 7 refs (See N63-14926 11-16) OTS: $2.25

An evaluation is presented of the use of gas chromatography in atmosphere sampling and analysis as a substitute, at least in part, for the present atmosphere analyzer. Both gas-liquid and gas-solid chromatography are discussed. An interesting development in gas chromatography from the standpoint of possible application to nuclear submarines is the so-called "industrial" or "process" chromatograph. This chromatograph is completely automatic and is used to monitor the composition of process streams in chemical plants and refineries. The cycle of the instrument is programed by a timing mechanism; a sample is injected, each peak is attenuated to the proper value, and the chromatograph is prepared for the next sample. Readout is usually in the form of bar-graph presentation: only the height of each peak of interest is recorded in each cycle. Often the output of the chromatograph itself activates valves to keep the reactants in a process at their optimum concentrations automatically. I.v.L.

N63-14934 Naval Research Lab., Washington, D.C.

ATMOSPHERE ANALYZERS

F. S. Thomas *In its* Present Status of Chemical Research in Atmosphere Purification and Control on Nuclear-Powered Submarines Aug. 29, 1962 p 59–62 4 refs (See N63-14926 11-16) OTS: $2.25

The state-of-the-art of the Mark III and the new Mark IV analyzers is reviewed. These analyzers are the service equipment in nuclear submarines for determining the concentration of the principal components of the submarine atmosphere. I.v.L.

N63-14935 Naval Research Lab., Washington, D.C.

CARBON SAMPLING OF SUBMARINE ATMOSPHERES

W. D. Smith and J. E. Johnson *In its* Present Status of Chemical Research in Atmosphere Purification and Control on Nuclear-Powered Submarines Aug. 29, 1962 p 63–66 5 refs (See N63-14926 11-16) OTS: $2.25

This review includes: (1) the contribution of the carbon sampling program in establishing the fact that a large portion of the hydrocarbon contamination in submarine atmosphere was due to paints and solvents, thus leading to the development of water-thinned paints; and (2) the development of new carbon samplers. I.v.L.

N63-14936 Naval Research Lab., Washington, D.C.
LEAK DETECTORS
F. S. Thomas *In its* Present Status of Chemical Research in Atmosphere Purification and Control on Nuclear-Powered Submarines Aug. 29, 1962 p 67-71 6 refs (See N63-14926 11-16) OTS: $2.25

Leak detectors for locating gas and vapor leaks from sealed spaces into the surrounding atmosphere are investigated. Results indicate that : (1) If only one leak detector is to be carried and used aboard during nuclear submarine operations, the Naval Research Laboratory thermistor-bridge leak detector is the unit of choice, due to its wide range of application and its nonspecificity. (2) For hunting halide leaks, it would be desirable to also have the GE H-6 halide leak detector available, especially during presubmergence system inspections, due to its selectivity and higher sensitivity for these gases. I.v.L.

N63-14937 Naval Research Lab., Washington, D.C.
INFRARED ANALYSIS OF ATMOSPHERE CONTAMINANTS
R. E. Kagarise and R. A. Saunders *In its* Present Status of Chemical Research in Atmosphere Purification and Control of Nuclear-Powered Submarines Aug. 29, 1962 p 72-82 3 refs (See N63-14926 11-16) OTS: $2.25

An analysis of the constituents of submarine atmosphere is reviewed. Results indicate that no single approach appears to be adequate for the satisfactory solution to this problem. Gas chromatography lacks the specificity to identify compounds because of the number of compounds present and because of their diverse chemical nature. For example, any given sample will probably contain aliphatic, olefinic, and aromatic hydrocarbons, alcohols, aldehydes, halogenated compounds, etc. Infrared spectroscopy alone is not satisfactory, primarily because of the complexity of the mixture. However, by combining these two methods through the utilization of efficient collecting and sampling techniques, it is possible to make considerable progress toward the identification or characterization of the major portion of the contamination in nuclear submarine atmosphere. I.v.L.

N63-14938 Naval Research Lab., Washington, D.C.
THE CO/H^2 BURNERS
F. S. Thomas *In its* Present Status of Chemical Research in Atmosphere Purification and Control on Nuclear-Powered Submarines Aug. 29, 1962 p 83-85 4 refs (See N63-14926 11-16) OTS: $2.25

Heat exchangers for use in conjunction with the CO/H_2 burner are investigated. Results of this investigation have lead to the procurement of heat exchanger units with No. 304 stainless steel frames and Hastelloy F wire matrixes as original equipment of the Mark III burners and as replacements for the Mark II burners. This should drastically reduce the magnitude of corrosion, thus also reducing the clogging problem. Further alleviation of clogging should result from the use of prefabricated burner-input air filters which will not leak aerosols into the burners. This leakage has undoubtedly often occurred with shipboard application of filter paper to the filter frame. I.v.L.

N63-14939 Naval Research Lab., Washington, D.C.
AEROSOLS IN NUCLEAR SUBMARINES
W. L. Anderson and J. L. Bitner *In its* Present Status of Chemical Research in Atmosphere Purification and Control on Nuclear-Powered Submarines Aug. 29, 1962 p 86-92 4 refs (See N63-14926 11-16) OTS: $2.25

The aerosol problem, i.e., the accumulation of finely divided particles of solids and liquids suspended in air, encountered during the submergence of nuclear-powered submarines has been studied, and specific recommendations for its solution have been made. The essential design criteria and performance of commercially available precipitators has been established. Modular construction of the units allows the stacking of basic units to achieve the desired capacity of filtered air. Dependent upon air flow rates and/or space requirements, removal efficiencies as high as 99.9% are practical. Preliminary results from the ships with the increased precipitator capacity show the aerosol concentrations to be some three to seven times less than that observed previously. This reduction in aerosol concentration is in line with that expected by the increased electrostatic precipitator capacity. It is believed that the aerosol problems on nuclear submarines have been minimized, and only intermittent monitoring of the submarine atmosphere for aerosols should be required. Electrostatic precipitators should now be considered as a standard item of the ship's equipment, and maintenance of the units can be performed by the ship's force. It is concluded that the major research and development effort has been completed and that further commitments by the Naval Research Laboratory in this area will be very minor in extent. I.v.L.

N63-14940 Naval Research Lab., Washington, D.C.
CATALYTIC COMBUSTION OF FREONS
Jack G. Christian *In its* Present Status of Chemical Research in Atmosphere Purification and Control on Nuclear-Powered Submarines Aug. 29, 1962 p 93-96 7 refs (See N63-14926 11-16) OTS: $2.25

Catalytic combustion studies using hopcalite were undertaken in the light of understanding the behavior of halogenated methanes and ethanes and, especially, the Freons. Results indicated that the amount of degradation of the halogenated compounds studied ranged from slight, in the case of Freon 12, to excessive, in the case of methyl chloroform. Decompositions products include the halogen acids, whose toxicity and corrosiveness are known; in the case of methyl chloroform, at least three additional degradation products were detected, presumably organic in nature, whose toxicology is speculative. The conclusion can be drawn that the use of volatile halogenated compounds on board nuclear submarines should be avoided where possible. I.v.L.

N63-15037 Centre d'Essais en Vol. Lab. Médico-Physiologique, Brétigny-sur-Orge (France)
LABORATOIRE MÉDICO-PHYSIOLOGIQUE [MEDICAL-PHYSIOLOGICAL LABORATORY]
[1962] 47 p In French

The organization, function, and facilities of the French medical-physiological laboratory are explained in detail. Facilities include equipment for high-altitude studies, bioclimatology, acceleration studies, biochemistry, veterinary medicine, centrifugal force, simulation, and measurement. D.E.R.

N63-15041 Mississippi State U., State College
BIOCHEMICAL STUDY OF MIXED CULTURE PROTOTYPE IN A CLOSED ECOLOGICAL SYSTEM NASA Progress Report No. V, July 1, 1962-Dec. 1, 1962
Robert G. Tischer [1962] 123 p 32 refs
(NASA Grant NsG 80-60)
OTS: $10.10 ph, $3.89 mf

Quantitative tests were run on the following: (a) the utilization and depletion of urinary nitrogen constituents by selected molds and yeasts; (b) the utility of extracellular products of algal metabolism as nutrients for the growth of other micro-organisms; (c) the oxidation of fecal fat by a species of *Pseudomonas* intended as an energy supplement for urine; (d) oxidation of citric and lactic acids studied from the standpoint of a carbon-energy source for bacteria growing on urine; (e) and the formation of polysaccharide materials by algae and bacteria. The findings should prove useful to the conversion and utilization of human waste products in closed ecological systems in outer space. D.E.R.

N63-15068 Naval Radiological Defense Lab., San Francisco, Calif.

DIFFERENTIAL RESPONSE TO ALLOGENIC AND XENOGENIC SKIN GRAFTS BY SUBLETHALLY IRRADIATED (670 rad) AND NON-IRRADIATED MICE SENSITIZED BY VARIOUS MEANS

M. L. Tyan and L. J. Cole Mar. 11, 1963 22 p 13 refs
(USNRDL-TR-628)

Twelve- to 14-week-old female LAF_1 mice were presensitized either with 3 i.p. injections of BALB/c or of rat spleen, skin cells, or by two consecutive BALB/c or rat skin tail grafts. One week following the last injection or the rejection of the second skin graft, the mice either were grafted with LAF_1, BALB/c, C3D/2, and rat skin, or they received 670 rad whole-body X-radiation and were grafted immediately thereafter. The data indicate that skin grafts induce a more vigorous and more radioresistant "second-set" response than do dissociated cells. Presensitization with allogenic spleen cells resulted in prolonged survival of subsequent allogenic skin grafts in sublethally irradiated mice. The second-set response to a xenogenic skin graft was found to be more radioresistant than was that to an allogenic graft. The converse was true with regard to the first-set response. Author

N63-15076 Aerospace Medical Div. Aeromedical Research Lab. (6571st), Holloman AFB, N. Mex.

BIODYNAMICS: PAST, PRESENT AND FUTURE

Ellis R. Taylor Mar. 1963 23 p 26 refs
(ARL-TDR-63-10)

A brief operational definition of biodynamics is presented. Following a condensed history of the field, including a review of weaknesses of the transient mechanical analytic approach, present biological research activities are listed. A definition of working relationships between disciplines is advanced. Author

N63-15130 Sloan-Kettering Inst. for Cancer Research, New York, N.Y.

ACUTE EFFECTS OF RADIATION EXPOSURE IN MAN

J. J. Nickson (Memorial Hospital, New York, N. Y.) *In* Atomic Energy Commission. Div. of Tech. Inform., Wash., D. C. Protection Against Radiation Hazards in Space Proc. of the Symp. at Gatlinburg, Tenn., Nov. 5–7, 1962 p 269–274 3 refs (See N63-15114 11-28) OTS: $7.00
(Paper C-1)

The data arises from three sorts of observation: first, those on patients who receive total body radiation in an attempt to ameliorate some ailment; second, accounts of nuclear accidents involving reactors; and third, the consequences of exposure to the events after the use or testing of nuclear weapons. An acute syndrome may be divided into events associated with effects upon the function of the marrow, upon the epithelium or the gastrointestinal tract, upon the skin, and upon the central nervous system. The number of observations relating to biochemical alterations is increasing. These changes will be described and discussed. Major emphasis will be given to those abnormalities from which recovery may occur. An attempt is made to relate dose time considerations to the kinds of effects seen. Author

N63-15131 Argonne National Lab., Ill.

LATE EFFECTS IN MAN FOLLOWING EXPOSURE TO IONIZING RADIATIONS

Douglas Grahn *In* Atomic Energy Commission. Div. of Tech. Inform., Wash., D. C. Protection Against Radiation Hazards in Space Proc. of the Symp. at Gatlinburg, Tenn., Nov. 5–7, 1962 p 275–290 25 refs (See N63-15114 11-28) OTS: $7.00
(Supported by the AEC)
(Paper C-2)

The after effects of radiation exposure have been examined in two broad categories, somatic and genetic. The biological expectations are discussed, and comments are made on the physical exposure parameters. Whole-body-exposure hazards are seen to be important in planning any space venture. Also, the shielding considerations concerned are outlined. D.E.R.

N63-15133 California U., Berkeley. Donner Lab.

BIOLOGICAL EFFECTS OF HIGH ENERGY PROTONS

C. A. Sondhaus *In* Atomic Energy Commission. Div. of Tech. Inform., Wash., D. C. Protection Against Radiation Hazards in Space Proc. of the Symp. at Gatlinburg, Tenn., Nov. 5–7, 1962 p 309–342 16 refs (See N63-15114 11-28) OTS: $7.00
(Supported by the AEC)
(Paper C-4)

Proton fluxes of solar origin constitute the main radiation hazard in space. This report summarizes the work done on the study of proton radiation, the semiempirical expressions describing solar proton spectral energy distribution, dose calculations, physical exposure factors, and irradiation effects. Data are presented and summarized from the few radiobiological studies of proton radiation that have been conducted. The 184-inch cyclotron and other apparatus, now under construction, which will be used to study whole body doses of proton radiation on large animals, are described. D.E.R.

N63-15134 Aerospace Medical Div. School of Aerospace Medicine, Brooks AFB, Tex.

EFFECTS OF ACUTE RADIATION EXPOSURE ON HUMAN PERFORMANCE

R. B. Payne *In* Atomic Energy Commission. Div. of Tech. Inform., Wash., D. C. Protection Against Radiation Hazards in Space Proc. of the Symp. at Gatlinburg, Tenn., Nov. 5–7, 1962 p 343–374 55 refs (See N63-15114 11-28) OTS: $7.00
(Paper C-5)

Fifty studies of anthropoid behavior have shown that behavioral functions are highly resistant to acute whole-body radiation doses well above the level required to produce troublesome physiological manifestations. But several aspects of behavior are clearly not impregnable. Further effort is being expended to relate such aspects of behavior to both the physical dimensions of the radiation environment and the visible damage produced in tissues. It is suggested that the ruling exposure factor is still the permissible acute exposure level. Some effects studies are: learning and retention, generalization of habits, manipulation, delayed response, attentiveness to environmental cues. D.E.R.

N63-15135 Physics Technology, Dept., Seattle, Wash.

THE LETHAL EFFECTIVENESS OF A SOLAR FLARE-TYPE DOSE DISTRIBUTION DELIVERED TO THE RAT

K. L. Jackson *In* Atomic Energy Commission. Div. of Tech. Inform., Wash., D. C. Protection Against Radiation Hazards in Space Proc. of the Symp. at Gatlinburg, Tenn., Nov. 5–7, 1962 p 375–392 26 refs (See N63-15114 11-28) OTS: $7.00
(Paper C-6)

An investigation of some biological effects produced by exposure of rats to a solar flare-type depth-dose distribution has been carried out. Space proton doses to bone marrow will not be appreciably attenuated by surrounding bone, and in the present study, this was simulated by use of cobalt-60 gamma radiation. Depth-dose distribution, produced in rats by a filter-rotation technique, resulted in a midline dose which was 25 percent of the surface dose. This depth-dose is similar to that calculated for exposure of man to July 16, 1959, solar-flare protons with 10 gm/cm^2 of shielding. The 50 percent lethal dose (LD_{50}) measured at the surface of

the rat was three times greater for depth-dose exposure as compared to uniform exposure. The midline LD_{50} was less for depth-dose exposure than for uniform exposure. The depth in the body at which the depth-dose LD_{50} was equal to the uniform LD_{50} was approximately 50 percent of the distance from the surface to the midline. The total energy absorbed at the LD_{50} was 1.5 times greater with depth-dose exposure as compared to uniform exposure. Mean survival time of decedents in the LD_{16} to LD_{84} range was significantly shorter in depth-dose exposed animals as compared to uniformly exposed animals. This suggests that depth-dose exposure produces greater injury to the intestine, which was verified by measurement of intestinal weight changes. Author

N63-15137 Oak Ridge National Lab., Tenn.
SOME DATA ON THE RELATIONSHIP OF RBE AND LET
W. S. Snyder *In* Atomic Energy Commission. Div. to Tech. Inform., Wash., D. C. Protection Against Radiation Hazards in Space Proc. of the Symp. at Gatlinburg, Tenn., Nov. 5–7, 1962 p 402–408 8 refs
(See N63-15114 11-28) OTS: $7.00
(Paper C-8)

The RBE of one radiation with respect to a standard radiation is usually defined as the inverse ratio of doses required to produce the same degree of a specified biological effect. It is well known that the RBE depends not only upon the quality of the radiations but also upon such conditions of exposure as dose rate, fractionation of dose, strain and conditions of animals, and the biological effect studied. This paper analyzes some experimental data to obtain an indication of the dependence of RBE on LET. The cases considered include some experimental studies of effects on cells and on mice. The interpretation of such data for certain conditions of exposure in space is discussed in a preliminary way. Author

N63-15142 General Dynamics/Fort Worth, Tex.
SECONDARY-PARTICLE DOSE CONTRIBUTIONS INDUCED BY SOLAR PROTON RADIATION
R. K. Wilson and R. A. Miller *In* Atomic Energy Commission. Div. of Tech. Inform., Wash., D. C. Protection Against Radiation Hazards in Space Proc. of the Symp. at Gatlinburg, Tenn., Nov. 5–7, 1962 p 595–607 7 refs (See N63-15138 11-28) OTS: $7.00
(NASA Contract NAS5-1093)
(Paper D-5)

A study was made to determine the biological hazard due to secondary radiation components—those produced in bulk shielding by high-energy extraterrestrial protons. An idealized shield system—spherical-shell shield with a differential-volume water-target at the center—was chosen for the study. A comparison was made of the physical dose due to primary protons penetrating the shield and the secondaries produced in the shield. It was found that (1) shield-target geometry and target model greatly influence the ratio of primary proton-to-secondary component dose, and (2) secondaries may well be important for shield thicknesses greater than about 10 gm/cm^2 in the case of an aluminum shield and a solar-flare proton spectrum. Author

N63-15144 Oak Ridge National Lab., Tenn.
THE CALCULATION OF RADIATION DOSE IN TISSUE FROM HIGH-ENERGY PROTONS
J. E. Turner, J. L. Feuerbacher, C. D. Zerby, W. E. Kinney, J. Neufeld, W. S. Snyder, and R. L. Woodyard *In* Atomic Energy Commission. Div. of Tech. Inform., Wash., D. C. Protection Against Radiation Hazards in Space Proc. of the Symp. at Gatlinburg, Tenn., Nov. 5–7, 1962 p 619–632 5 refs (See N63-15138 11-28) OTS: $7.00

For the estimation of dose from high-energy radiation, particle histories have been analyzed in a tissue slab of thickness 30 cm from normally incident protons with energies of 100, 150, 200, 250, 300, 350, and 400 Mev. The results of the calculation of rad and rem dose as a function of depth in the tissue slab are presented. Also shown at each incident energy is the relative contribution of recoil nuclei (and other particles with mass number $A > 1$) to the total absorbed energy per unit mass. A method for analyzing particle histories is utilized which will later permit computations of rem dose curves under very general assumptions about the dependence of RBE on LET. The rem dose, as presented here, uses the estimation of LET as formulated by Neufeld and Snyder, and is calculated using their methods. Author

N63-15145 Boeing Co., Seattle, Wash.
SPACE PROTON DOSES AT POINTS WITHIN THE HUMAN BODY
David L. Dye *In* Atomic Energy Commission. Div. of Tech. Inform., Wash., D. C. Protection Against Radiation Hazards in Space Proc. of the Symp. at Gatlinburg, Tenn., Nov. 5–7, 1962 p 633–661 15 refs (See N63-15138 11-28) OTS: $7.00
(Paper D-8)

In this paper are presented the doses at twelve specific points in the body of a seated man exposed to isotropic incident space protons, where the man is inside various thicknesses of external vehicle-shell shielding. The body points, selected for their radiobiological interest, are in (or on) sternum, chest skin, femur, spinal column, eye, central gut, and a series at various lateral depths on the waist. The protons reaching these specific points from all directions traverse tissue thicknesses that were determined from scale drawings of a statistically standard man (75-percentile). The proton penetration, secondary radiation generation, and total dose delivered to each specific body point was calculated using an IBM (FORTRAN) computer code. Author

N63-15159 Yale U., New Haven, Conn.
THE BIOLOGICAL HAZARDS OF π AND μ MESONS
B. L. Murphy, P. Kitching, and H. B. Knowles *In* Atomic Energy Commission. Div. of Tech. Inform., Wash., D. C. Protection Against Radiation Hazards in Space Proc. of the Symp. at Gatlinburg, Tenn., Nov. 5–7, 1962 p 866–875 6 refs (See N63-15138 11-28) OTS: $7.00
(Paper F-6)

The biological hazard of both kinds of π and μ mesons has been very roughly evaluated for the purpose of estimating shielding about a meson factory. Certain processes relative to the probable interactions of stopped mesons are discussed in detail because of their relevance to shielding against high-energy proton fluxes. In particular, stopping π^- mesons appear to be of the order of ten times more dangerous than neutrons of the same energy, and the importance of this ratio is noted for the case of thin space shields. Techniques for an improved calculation of the hazard are considered. Author

N63-15202 Florida U. Coll. of Medicine, Gainesville
EFFECT OF CHRONIC EXPOSURE TO HYPOXIA ON BLOOD PRESSURE AND THYROID FUNCTION OF HYPERTENSIVE RATS
Melvin J. Fregly Mar. 1963 12 p 22 refs
(Contract AF 41(657)-370)
(SAM-TDR-63-4)

Chronic exposure to an atmosphere containing 13% oxygen protects against development of renal hypertension in rats. The mechanism through which the rats are protected may involve the thyroid gland, since certain criteria for assessment of thyroid function, using radioactive iodide, suggest depression of activity. Other physiologic mechanisms, brought into play as a result of hypoxia, may also contribute. Author

17 MACHINE ELEMENTS AND PROCESSES

Includes: bearings, seals, pumps, and other mechanical equipment; lubrication, friction, and wear; manufacturing processes and quality control; and materials fabrication, handling, and inspection.

For related information see: 06 Auxiliary Systems.

N63-14735 Convair, Fort Worth, Tex.
MATERIALS—SOLID FILM LUBRICANTS—IRRADIATION AT FOUR AND ONE TEMPERATURE—EFFECTS OF [Report on Tests] Nov. 25, 1957 to Feb. 7, 1958
J. H. Mc Kenna Feb. 28, 1958 16 p 1 ref
(Contracts AF 33(600)-32054 and AF 33(657)-7248)
(FGT-1880)

In order to determine the effects of nuclear radiation on Electrofilm #4396 solid film lubricant, test specimens, as received from the vendor, were exposed to four flux levels at ambient temperature in Materials Component Irradiation #6. Results of the tests showed a marked increase in wear-life of irradiated specimens. Significantly, this increase followed a positive slope from Flux I (lowest level) to Flux III, and then a negative slope to Flux IV (highest level). Concurring with nuclear studies over the past few years, the test data indicated that irradiation was responsible for polymerization of the resin binder in the lubricant film, promoting cross-linking of the polymer bond and thereby causing better film adhesion. At Flux III, this phenomenon theoretically reached the maximum permissible radiation level for this polymer. At Flux IV, excessive crosslinking probably caused embrittlement of the polymer, resulting in somewhat decreased adhesion and wear-life characteristics of the lubricant. Author

N63-14743 Pfaudler Co., Rochester, N. Y.
DEVELOPMENT OF PRACTICAL TECHNIQUES FOR APPLYING PROTECTIVE COATINGS TO COLUMBIUM ALLOYS Quarterly Progress Report No. 3, Covering Period 1 Dec. 1962 to 28 Feb. 1963
J. Zupan, P. J. Chao, and J. B. Whitney Mar. 15, 1963 28 p 1 ref
(Contract AF 33(657)-8920)
(PF-63-3)

Practical techniques for applying protective coatings to columbium alloys are being investigated by studying three coating processes: fused salt bath, fluidized bed, and slurry dip and spray application. The use of D-14 alloy (Cb-5Zr), 20 mils thick, is being continued as the substrate. In the fused salt bath work, deposition of chromium and titanium continued to be investigated, with emphasis being placed on bath composition and selection of bath container material. The bulk of the work on fluidized bed deposition has continued to be concerned with the investigation of basic process variables. Metallographic evaluation of the samples is being employed to determine the optimum combination of these variables. Studies of slurry dip and spray technique have included investigation of the effects of process variables such as firing time and the use of flake vs. granular aluminum and tin powders. Since granular powders produce better coatings, means of improving their suspension properties will be investigated. The new electrophoresis equipment is being used to study the basic mechanisms of these suspension properties. Author

N63-14792 Union Carbide Nuclear Co., Oak Ridge, Tenn.
A VERSATILE SPECTROMETER MAGNET POWER SUPPLY
W. A. Groppe Apr. 19, 1963 27 p
(Contract W-7405-eng-26)
(Y-1414) OTS: $0.50

A more versatile magnet supply was needed for mass spectrometer work. Commercial equipment which fits all the desired applications was not available. An instrument, incorporating controls to allow simpler and better readout of peaks than was before possible, was designed, fabricated, tested, and installed. Early results from actual laboratory operation show satisfactory performance from both the operating and maintenance standpoints. Author

N63-14816 Mechanical Technology, Inc., Latham, N. Y.
BEARING MATERIALS FOR PROCESS FLUID LUBRICANTS Progress Report II
M. B. Peterson Feb. 1963 42 p 23 refs
(Contract Nonr-3731(00)(FBM))
(MTI-63TR8)

In this phase of the investigation, materials selected on the basis of the various criteria for sliding effectiveness were evaluated in low-speed friction tests for their surface-damage characteristics. The following results were obtained: (1) For all the materials tested, except iron, very little difference could be detected in the sliding characteristics in water, wet steam, dry steam, or air; this permits extrapolation of data obtained in air. (2) The criteria of nonsolubility and formation of soft oxide films appeared to be the most suitable criteria for material selection. (3) Of the materials suitable for use at 500° F, gold gave the least surface damage and merits further consideration for development of solft bearing materials. (4) A wide variety of other materials are available for use as bearing materials or sliding components based on the specific bearing design and operating conditions. (5) A low yield point will result in a lower surface-operating temperature. This, however, does not necessarily mean less tendency to fail. Author

N63-14854 Fansteel Metallurgical Corp., North Chicago, Ill.
TUNGSTEN SHEET ROLLING PROGRAM Final Report, June 1, 1960 through Mar. 1, 1963
George C. Bodine, Jr. Mar. 1, 1963 93 p
(Contract NOw-60-0621-c)

Powder metallurgy tungsten plate and sheet has been produced in quantity according to optimum processing procedures developed in the pilot powder and sheet phases. Inspection and test results show the material to be of good quality but not as consistent as full-scale pilot material. Examination of all program data indicates that extremely close controls are an absolute prerequisite for the production of consistent and reliable powder metallurgy tungsten plate and sheet. This final report contains a condensation of all significant information contained in previous interim reports, subsequent work, a complete description of the finished articles, and recommendations. Author

N63-14892 Los Alamos Scientific Lab., N. Mex.
ELEVATED TEMPERATURE DIFFUSION BONDING OF TUNGSTEN TO TUNGSTEN UNDER PRESSURE
R. I. Batista, G. S. Hanks, and D. J. Murphy Mar. 22, 1963 56 p 15 refs
(Contract W-7405-eng-36)
(LA-2751)

Solid-state diffusion bonding of tungsten to tungsten was investigated at temperatures ranging from 1700° to 2600° C, under surface contact pressures up to 3000 psi, while under high vacuum or hydrogen atmosphere. Various interface coatings were employed to promote diffusion, including graphite, oxide, metal slurries, electroplates, direct surface oxidation, and Mo-W deposits from carbonyl decompositions. Thorough metallurgical bonding was achieved, particularly with the latter two surface coatings, after 2 hours at 2350° C in H_2 under 1400 psi. Corresponding tensile strengths of 30,000 psi were obtained. Powder-compacted tungsten sheet containing 50 v/o UO_2 spray-coated with an outer layer

of tungsten, was effectively bonded to itself and to tungsten metal under 2-hour diffusion treatments at 2000° C and moderate pressures of the order of 1000 psi. Author

N63-14963 Atomics International, Canoga Park, Calif.

DEVELOPMENT OF NIOBIUM DIFFUSION BARRIERS FOR ALUMINUM-CLAD URANIUM ALLOY FUEL ELEMENTS

B. N. Briggs and W. H. Friske [1962] 52 p 23 refs
(Contract AT(11-1)-GEN-8)
(NAA-SR-7973) OTS: $1.00

Nickel has been used as a diffusion barrier for Al-clad uranium alloy fuel elements, operating at 650° F in organic-cooled reactors. Advanced organic-moderated reactor (AOMR) concepts include operating temperatures up to 850° F. Since the interdiffusion of Al-Ni is 150 times faster at 850° F than at 650° F, an alternate diffusion barrier is required. Subsequent studies resulted in the selection of niobium. Several techniques for bonding niobium to the U - 10 Mo fuel were investigated. After considerable development effort, electron-beam vacuum deposition yielded adherent, nonporous, ductile coatings. Isostatic bonding, at 1050° C and 12,000 psi for 1 hr, also resulted in metallurgically bonded niobium on the major surfaces of U - 10 Mo fuel plates. Author

N63-15032 Space Technology Labs., Inc., Redondo Beach, Calif.

ADVANCED VALVE TECHNOLOGY FOR SPACECRAFT ENGINES Final Report [Feb. 25, 1962–Jan. 25, 1963]

B. P. Brady and R. J. Salvinski Mar. 1963 360 p refs
(NASA Contract NAS7-107)
(Rept. 8651-6016-RU-000) OTS: $21.00 ph, $11.00 mf

This final report describes the work that was done to determine the state-of-the-art of valves required for space exploration vehicles and the steps that were taken to advance the technology. A novel valve concept was developed, and a prototype valve was built and successfully tested. A seal compound of Teflon and stainless steel was developed which possesses superior cold-flow characteristics while retaining the desirable properties of the basic Teflon material. Author

N63-15034 General Dynamics/Pomona, Calif.

ANELASTIC BEHAVIOR OF TANTALUM AND COLUMBIUM [Final Report, Mar. 1960–Oct. 1961]

R. J. Sneed, E. L. Fink, and M. C. Abrams Wright-Patterson AFB, Ohio, Directorate of Materials and Processes, Feb. 1963 128 p 49 refs
(Contract AF 33(616)-7235)
(ASD-TDR-62-323)

A theoretical model is developed based on dislocation-interstitial interaction during stress application, which describes the anelastic behavior of bcc metals particularly during yield delay. It is shown that the reorientation of interstitial impurities apparently controls both the preyield microstrain rate and the time to yield. The model is supported for tantalum and columbium by the results of yield-delay experiments over a temperature range from −97° F to 400° F. Activation energies of the yield-delay process, calculated both from microstrain rate data and time-to-yield information, indicate that hydrogen diffusion has a controlling effect, with other interstitials contributing to the effective activation energies at the higher temperatures. Temperature-insensitive stress effects are noted. The model is further substantiated by X-ray diffractometry which demonstrates the occurrence of anelastic lattice strains during load application and their consequent recovery. A brief résumé is given on the initial efforts of a high-temperature study on the anelasticity in tantalum and columbium. This study is aimed at exploring anelastic behavior up to 3000° F. Author

N63-15100 Smith (A. O.) Corp., Milwaukee, Wis.

GLASS SURFACE CHEMISTRY FOR GLASS FIBER REINFORCED PLASTICS Progress Report No. 13, Mar. 1–Mar. 31, 1963

F. W. Nelson Apr. 15, 1963 12 p 7 refs

Bond life of Owens-Corning HTS finished E glass was more than 12 days in 190° F water. Wetting of HTS glass, as determined by the captive bubble technique, was similar to epoxy resin coated glass. The contact angle was 81 to 90, indicating a high degree of nonwetting by water. Bond life of aluminum was also studied as part of the exploratory work on bond-strength testing. Bond life of as-rolled aluminum, whether treated with A-1100 or not, was poor (less than one day). Recent work has indicated that the bond-strength test could be modified to minimize the effect of stresses created by the shrinkage of the high expansion resin during curing. Testing of bond strength by the chain method showed that bonding to the chemically cleaned, optical flat E-glass surface was less effective than to the as-cast surface, whether treated with A-1100 or not. It was also established with 98-percent confidence that treatment of the optical flat surface with A-1100 caused a slight increase in bond strength. Author

N63-15177 Ladish Co., Cudahy, Wis.

INVESTIGATION OF THE EFFECTS OF MELTING PROCESSES UPON THE TRANSVERSE DUCTILITY OF H-11 STEEL AT HIGH STRENGTH LEVELS Interim Engineering Report No. 3, June 23–Sept. 23, 1962

Joseph C. Truszynski and Jack A. Yoblin Wright-Patterson AFB, Ohio, Mfg. Tech. Lab., Oct. 1962 66 p 36 refs
(Contract AF 33(600)-38767)
(ASD-TR-7-678(III))

The statistical analysis of transverse strength and ductility in ultrahigh-strength H-11 steel processed by air melting and by vacuum-arc remelting is summarized. The four vacuum-arc-remelt process variations selected for investigation are discussed, and metallurgical requirements for this material are specified. The analysis of transverse strength and ductility at the 280 to 300 Ksi and 300 Ksi minimum-strength levels established that strength and ductility tend to decrease with increasing billet size, that surface specimens exhibit the most favorable properties (presumably because they have received the greatest amount of hot working), that consumable electrode vacuum-remelted steel is unquestionably superior to either electric-furnace air-melted or air-melted–vacuum-degassed steel, and that there exists considerable variation in properties between mills for a given billet size and between billet sizes of a given mill. The following vacuum-arc remelt process variations were selected for investigation: (a) air melt—vacuum arc remelt, (b) air melt—double vacuum arc remelt, (c) vacuum degas—vacuum arc remelt, and (d) vacuum induction melt—vacuum arc remelt. Author

N63-15197 Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho

CHEMPUMP PERFORMANCE FOR HIGH TEMPERATURE ORGANIC SERVICE

R. G. Young AEC Natl. Reactor Testing Station, Mar. 15, 1963 30 p
(Contract AT(10-1)-205)
(IDO-16844) OTS: $0.50

Performance testing of the two canned-type pumps being used for high-temperature service in the Experimental Organic Cooled Reactor has been completed. Testing showed that there is a tendency for gases to build up in the pump rotor cavity and heat exchanger, resulting in pump overheating. This problem can be corrected by redesigning the heat exchanger to provide proper venting. An external self-venting heat exchanger was designed and installed on the two-stage pump. Testing showed satisfactory performance of the modified pump. Additional testing to determine

pump life was not completed due to termination of the EOCR program. A summary of operation for the test pumps is presented.
Author

18 MATERIALS, METALLIC

Includes: cermets; mechanical and physical properties of alloys and metals; and metallurgy.

For related information see: 07 Chemistry; 17 Machine Elements and Processes; 19 Materials, Non-metallic; 33 Stresses and Loads; and 34 Structural Design.

N63-14719 Battelle Memorial Inst., Columbus, Ohio
FISSION-PRODUCT MIGRATION IN AND RELEASE FROM IRON-20 w/o CHROMIUM
Josef Bugl (Euratom), Arthur A. Bauer, George G. Cocks, Thomas S. Elleman, James E. Howes, Jr., David L. Morrison, and Fitz R. Winslow Jan. 25, 1963 52 p 5 refs
(Contract W-7405-eng-92)
(BMI-1611; EURAEC-582)

Both in-pile and out-of-pile experiments were performed in a study of rare-gas and solid-fission-product diffusion in a body-centered-cubic iron-20 w/o chromium alloy. Fission-gas-release measurements during postirradiation heating of recoil-impregnated foils showed that release is time, temperature, and concentration dependent. The time and concentration dependence was tentatively interpreted in terms of fission-gas clustering or bubble nucleation and growth, although other mechanisms are being considered. Evidence of fission-gas bubble formation was obtained by transmission electron microscopy. Release of fission-product gases during irradiation of clad fueled samples was low and exhibited a half-life dependence. Precursor halogen diffusion may play a role in the observed gas release. Techniques for studying solid-fission-product diffusion were developed. Only limited data for diffusion during postirradiation heating were obtained. Diffusion rates for ruthenium were much greater than the rates for cerium and zirconium-niobium, which were similar.
Author

N63-14753 National Research Corp., Cambridge, Mass.
THE INFLUENCE OF SURFACE PHENOMENA ON THE MECHANICAL PROPERTIES OF STRUCTURAL MATERIALS (FATIGUE OF ALUMINUM IN VACUUM) Final Report, Jan. 1, 1961–Jan. 1, 1963
John L. Ham [1963] 74 p 22 refs Presented in part at the ASTM 4th Pacific Area Natl. Meeting, Oct. 1962
(Contract AF 49(638)-1005)

Techniques were developed for evaluating the fatigue life of metals by reverse bending in controlled gaseous environments, including high vacuum, and bombardment. These techniques were applied to electropolished specimens of commercially pure, half-hard rolled aluminum sheet. The fatigue life of aluminum in reverse bending at 125 to 140 cycles per second was found to be about seven times longer in vacuum than in wet air, and about four times longer in vacuum than in dry air. Life is independent of pressure in the range 760 to 10^{-2} torr; increases rapidly in the range 10^{-2} to 10^{-4} torr and is again independent of pressure in the range 10^{-4} to 7×10^{-9} torr. Life under argon bombardment is up to three times longer than in high vacuum. The cyclic strain causes more surface roughening in vacuum than in air. A hypothesis based on adsorption equilibrium and immunization to cracking by work hardening is proposed to explain the step change in life with pressure. The effectiveness of bombardment is ascribed to prevention of crack contamination by migration of mobile surface-gas films.
Author

N63-14828 Lockheed Missiles and Space Co., Sunnyvale, Calif.
THE EFFECT OF HYDROGEN ON ALUMINUM: AN ANNOTATED BIBLIOGRAPHY
C. G. Gros, comp. Mar. 1963 25 p 49 refs
(Special Bibliography SB-62-68)

The effect of hydrogen on aluminum is considered, with emphasis on welding at room temperature and on the ultimate reliability, in space applications, of aluminum thus treated; the bibliography covers the period from 1950 through 1962. A few citations to nonferrous metals, that might lead to information about aluminum, have been included. The resources of the Technical Information Center, Lockheed Missiles & Space Company, were utilized.
Author

N63-14835 General Electric Co. Power Tube Dept., Schenectady, N. Y.
INVESTIGATION OF VARIOUS ACTIVATOR REFRACTORY SUBSTRATE COMBINATIONS Final Report
John H. Affleck Mar. 5, 1963 103 p 87 refs
(Contract AF 19(628)-279)
(AFCRL-63-69)

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1. THE PROPERTIES REQUIRED FOR HIGH CURRENT DENSITY CATHODES J. H. Affleck p 63–80 17 refs (See N63-14836 11-18)
2. CONCLUSIONS CONCERNING THE LANGMUIR APPROACH N. J. Hawkins p 81–86 7 refs (See N63-14837 11-18)

N63-14836 General Electric Co. Power Tube Dept., Schenectady, N. Y.
THE PROPERTIES REQUIRED FOR HIGH CURRENT DENSITY CATHODES
John H. Affleck *In its* Investigation of Various Activator Refractory Substrate Combinations Final Report Mar. 5, 1963 p 63–80 17 refs Presented at the Sixth Natl. Conf. on Tube Techniques, Sept. 1962 Submitted for Publication (See N63-14835 11-18)
(Contract AF 19(628)-279)

The temperature-dependent rate processes involved in maintaining a stable uniform emitter surface in barium cathode tubes are investigated in order to determine the properties required to produce high current density cathodes. The following results are reported: (1) a barium-aluminate-coated cathode can produce an available current density of about 10 a/cm^2, and a barium-orthosilicate coated-cathode is capable of delivering current density in excess of 20 a/cm^2; (2) both the oxide and dispenser systems are capable of high current densities under pulsed conditions, but excessive heater temperature and correspondingly short heater life may prevent the attainment of 100 a/cm^2; (3) uncoated heaters should be used for higher current density applications, but even then the operating temperature of the heater may be too high to given an adequate lifetime; (4) the consequences of the evaporation rate must be examined for each application; and (5) the particle size of the refractory material is important in maintaining a uniform emitting surface.
M.P.G.

N63-14837 General Electric Co. Power Tube Dept., Schenectady, N. Y.
CONCLUSIONS CONCERNING THE LANGMUIR APPROACH
N. J. Hawkins *In its* Investigation of Various Activator Refractory Substrate Combinations Final Report Mar. 5, 1963 p 81–86 7 refs (See N63-14835 11-18)

A theoretical cluster model, based on an extension of Langmuir's thermodynamic approach, is proposed for the dispensing of activator atoms in cesium-on-tungsten surfaces. In this model, relatively fixed dipoles of ions are imaged to the surface in such

concentration ($\sim\theta$ = 0.01) that they form a composite electron affinity surface in the neighborhood of 3.87 volts with the substrate. Highly mobile neutrals cluster about these active centers in such a manner that the cluster as a whole is held by attracting dispersion forces, thereby (1) introducing a term of the opposite sign into the virial equation; (2) giving, in effect, a small measurable dipole moment; (3) providing an easy method for atoms to evaporate; and (4) providing continual dispensing of activator atoms to the ion site. However, this model would yield an extremely patchy type of emission because the active sites initially are provided by the high work function planes in the substrate. Since this model is partially both an internally and an externally dispersed system, the relations connecting emission and evaporation rate have not been investigated. M.P.G.

N63-14839 Air Force Cambridge Research Labs. Electronics Research Directorate, Bedford, Mass.

SPECTROGRAPHIC ANALYSIS OF TRACE ELEMENTS IN ALUMINUM OXIDE MATRICES

John J. Fitzgerald Jan. 1963 14 p 7 refs
(AFCRL-63-3)

Twenty-five trace elements in aluminum oxide matrices are determined by a spectrographic method. The oxide samples buffered with graphite are arced at high amperage and the spectral intensities measured by an external standard, pure aluminum oxide, excited similarly. The method is convenient, sensitive, precise, and more suited than chemical analysis, which would require an extended, difficult, and complex analytical scheme. It has been used routinely for the analysis of lasers and related materials. The concentration ranges covered for the impurities vary from 0.0001 and 0.0025 up to 0.010. Author

N63-14848 Armour Research Foundation, Chicago, Ill.

DISLOCATION MOBILITY AND PINNING IN HARD MATERIALS THROUGH INTERNAL FRICTION STUDIES [Final Report, Apr. 1, 1961-Mar. 31, 1962]

P. D. Southgate and A. E. Attard Wright-Patterson AFB, Ohio, Directorate of Materials and Processes, Feb. 1963 96 p 23 refs
(Contract AF 33(616)-8132)
(ASD-TDR-62-431)

The internal friction of covalently bonded and partly covalently bonded materials is being investigated at elevated temperatures. The apparatus operates on the electrostatic drive system, and covers the range 0 to 1500° C, 1 to 200 kc/s. Single crystals of silicon, silicon carbide, and zinc oxide have been measured. A steady rise of internal friction is seen in deformed silicon specimens above 500° C, which appears to be thermally activated with an activation energy of 1.61 ± 0.02 ev. The rise is attributed to the dislocation damping; its magnitude is approximately proportional to the dislocation density and inversely to the frequency. Quantitative identification can be made with Brailsford's abrupt-kink theory of dislocation damping if a reasonable kink density is assumed, in which case the activation energy is that of kink mobility. Observations of creep rate during deformation of silicon crystals at 950° C give rather variable results. The most common situation is that of approximately logarithmic creep, followed by some work hardening. Deviations occur in the form of an incubation time for creep, of a continuously increasing creep rate. Specimen orientation and oxygen content did not seem to have a major effect on behavior. Silicon carbide and zinc oxide were measured only in the undeformed state. A number of peaks were seen in zinc oxide (29 kc/s) at 135°, 190° and 345° C, and in silicon carbide (110 kc/s) at 500° C. Rapid rises in internal friction occurred above 750° C in zinc oxide and 900° C in silicon carbide. The peaks are too wide to be caused by simple point defect relaxation, and further data are required to identify them. The general annealing behavior of the rise in silicon carbide is very similar to that in an anomalous silicon specimen having a very nonuniform dislocation distribution. Author

N63-14882 Metcut Research Associates, Cincinnati, Ohio

MACHINING OF REFRACTORY MATERIALS, PHASE II Technical Engineering Report, 1 Nov. 1961-31 Jan. 1962

L. J. Nowikowski, N. Zlatin, and M. Field Wright-Patterson AFB, Ohio, Mfg. Tech. Lab., Feb. 1962 140 p
(Contract AF 33(600)-42349)
(ASD-TR-7-532a(V))

Machining studies were performed on pressed and sintered unalloyed tungsten, 90Ta-10W alloy, molybdenum TZM and Mo-0.5%Ti alloys, and D6AC steel quenched and tempered to 56 and 58 R_c. The investigation consisted of drilling tests on tungsten; face milling, end milling, drilling and grinding on 90Ta-10W alloy; turning and end milling on molybdenum alloys; and turning, face milling, slotting, end milling, reaming, grinding, distortion studies and residual stress analyses on D6AC steel. Author

N63-14883 Metcut Research Associates, Cincinnati, Ohio

MACHINING OF REFRACTORY MATERIALS, PHASE II Technical Engineering Report, 1 Feb. 1962-30 Apr. 1962

L. J. Nowikowski, N. Zlatin, and M. Field Wright-Patterson AFB, Ohio, Mfg. Tech. Lab., May 1962 97 p
(Contract AF 33(600)-42349)
(ASD-TR-7-532a(VI))

Machining studies were performed on pressed and sintered unalloyed tungsten, D-31 columbium alloy, 90Ta-10W alloy, molybdenum TZM and Mo-0.5% Ti alloys, and a high-temperature glass-ceramic material. The investigation consisted of drilling and grinding tests on tungsten; turning, face milling and grinding on D-31 columbium; turning, drilling, reaming and tapping on 90Ta-10W alloy; face milling, end milling, drilling, reaming, tapping and grinding on molybdenum alloys; and grinding of the high-temperature glass ceramic. Author

N63-14884 Metcut Research Associates, Inc., Cincinnati, Ohio

MACHINING OF REFRACTORY MATERIALS, PHASE II Technical Engineering Report, 1 May-31 July 1962

N. Zlatin, M. Field, and J. Gould Wright-Patterson AFB, Ohio, Mfg. Tech. Lab., Aug. 1962 125 p
(Contract AF 33(600)-42349)
(ASD-TR-7-532a(VII))

Machining studies were performed on pressed and sintered, forged and resintered, and arc cast unalloyed tungsten; D-31 columbium; 90Ta-10W alloy; silica reinforced phenolic resin; solid zirconium oxide; and zirconium and aluminum oxide coatings. The investigation consisted of face milling, end milling, drilling, and tapping studies on tungsten and D-31 columbium; turning, face milling, drilling and tapping on silica reinforced phenolic resin; grinding of solid and flame sprayed zirconium and aluminum oxide coatings; and turning, face milling, end milling, drilling, reaming, tapping, and grinding on the 90Ta-10W alloy. Author

N63-14885 Metcut Research Associates, Inc., Cincinnati, Ohio

MACHINING OF REFRACTORY MATERIALS, PHASE II Technical Engineering Report, 1 Aug.-31 Oct. 1962

N. Zlatin, M. Field, and J. Gould Wright-Patterson AFB, Ohio, Mfg. Tech. Lab., Nov. 1962 83 p
(Contract AF 33(600)-42349)
(ASD-TR-7-532a(VIII))

An evaluation of a Tornetic drilling unit and tapping unit is in progress. Drilling test results using the Tornetic drilling unit are compared with these using a constant feed and speed drill press on 4340 steel quenched and tempered to 52 R_c B-120VCA titanium at 400 BHN, and Rene 41 at 370 BHN. Author

N63-14886 Metcut Research Associates, Inc., Cincinnati, Ohio

MACHINING OF REFRACTORY MATERIALS, PHASE II Technical Engineering Report, 1 Nov. 1962-31 Jan. 1963

N. Zlatin, M. Field, and J. Gould Wright-Patterson AFB, Ohio, Mfg. Tech. Lab., Feb. 1963 133 p
[Contract AF 33(600)-42349]
(ASD-TR-7-532a(IX))

An investigation to determine the feasibility of high-speed milling (edge trimming) the thermal resistant alloys is in progress. Preliminary results obtained on 6Al-4V Titanium sheet and PH 15-7 Mo stainless sheet indicate that these alloys can be edge milled successfully at cutting speeds ranging from 500 to 2000 feet per minute. Author

N63-14889 Temco Electronics, Dallas, Tex.
MECHANICAL PROPERTIES OF MATERIALS FABRICATED BE SHEAR FORMING [Final Report, Feb. 1961–June 1962]
Frank Jacobs Wright-Patterson AFB, Ohio, Directorate of Materials and Processes, Feb. 1963 361 p 15 refs
(Contract AF 33(616)-7874)
(Rept. 00.384; ASD-TDR-62-830)

The effect of shear forming on the mechanical properties was determined for thirty-two alloys. The eight different classes of alloys included: (a) austenitic, ferritic, martensitic, and precipitation-hardening types of stainless steels, (b) super alloys, (c) titanium alloys, (d) alloy steels, and (e) aluminum alloys. All materials were shear formed into cones with room-temperature reductions of 20, 30, 40, 50, 60, and 70 percent. Each cone was formed with one pass of the shear form roller. Some alloys did not withstand the higher percentage reductions. Original material properties, properties after shear forming, and properties after shear forming plus heat treatment were determined. The typical microstructures of the various materials and conditions were recorded. Author

N63-15054 Brown U. Div. of Engineering, Providence, R.I.
STUDY OF TiC CRYSTALS
Hun-Chiang Yeh Feb. 1963 25 p 17 refs
(Grant DA-ARO(D)-31-124-G36)
(DA-G36; AROD-2662-5)

Electron microscopy studies of TiC have been shown to be feasible. The dislocation etch-pit shape is found to be orientation dependent. The plastic deformation by compression at elevated temperatures has been studied. The slip system is experimentally determined as $\{111\} < 110 >$. The properties of TiC are found very analogous to that of diamond cubic semiconductors. The binding in TiC is believed to be partially covalent. Author

N63-15064 Aerojet-General Corp. Ordnance Div., Downey, Calif.
INVESTIGATE THE EFFECT OF HIGH DYNAMIC PRESSURES UPON THE METALLURGICAL PROPERTIES OF IRON AND TITANIUM BASE ALLOYS [Final Report, Apr. 15, 1961–Apr. 14, 1962]
A. W. Hall, E. K. Henriksen, C. A. Landusky, and I. Lieberman Wright-Patterson AFB, Ohio, Directorate of Materials and Processes, Feb. 1963 196 p 22 refs
(Contract AF 33(616)-8191)
(ASD-TDR-62-535)

Effects of high dynamic pressures upon the metallurgical properties of iron and titanium-base alloys are given. Pressure levels ranging from 86 kilobars to 390 kilobars were used to demonstrate refinement of structure with indications of ausforming in H-11 steel shocked at elevated temperature, a reduction in retained austenite for heat-treated and tempered UHB-46 steel, and an increase in susceptibility to aging for B120VCA titanium. Metallurgical examinations of shocked specimens were conducted optically, with X-ray diffraction and with electron microscopy. Changes in hardness, structure, and dimensions were recorded and correlated with the pressures used. Hypotheses to explain the observed effects are presented. Details are presented which are pertinent to the explosive techniques developed for generating the dynamic shock, the recovery system employed to recover the specimens after shocking, and the problem areas associated with testing at elevated temperatures. Author

N63-15065 Mississippi State U., State College
NONDESTRUCTIVE ANALYSIS OF THE BRITTLE FRACTURE BEHAVIOR OF CERAMIC MATERIALS [Final Report, Sept. 1, 1960–Aug. 31, 1961]
J. H. Lauchner, T. F. Torries, and J. L. Pentecost Wright-Patterson AFB, Ohio, Directorate of Materials and Processes, Feb. 1963 58 p 62 refs (Contract AF 33(616)-7347)
(ASD-TR-61-436, Pt. I)

A literature survey of theoretical and experimental approaches to brittle fracture was directed toward a nondestructive evaluation point of view. Surface decorating techniques were investigated. A technique for calculating maximum stress in an elastic loop was developed and applied to the measurement of the strength of glass fibers from three to seven mils in diameter. The strength values were related to surface condition by surface decoration techniques. Surface flaw decoration of cleaned and polished surfaces was performed by condensation of water on the surface. Minute flaws estimated to be less than 1000 Å deep were easily revealed. Capacitance behaviors of polycrystalline materials were studied. Residual stress effects were observed under statically loaded conditions. Author

N63-15073 Titanium Metals Corp. of America, New York, N.Y.
DEVELOPMENT OF A STABLE BETA TITANIUM ALLOY First Quarterly Report, June 29–Sept. 30, 1962
H. W. Rosenberg Watertown, Mass., Watertown Arsenal Labs., 1962 35 p 2 refs
(Contract DA-30-069-ORD-3743)
(WAL-TR-405/2)

Twenty-seven titanium base alloys were melted, processed to sheet, and tested in two conditions of heat treatment. Three base alloys, Ti-17V-3Al, Ti-8V-8Mo-3Al, and Ti-15Mo-3Al were utilized. To each of these, 5% to 10% chromium, 5% to 10% manganese, and 2.5% to 7.5% iron were individually added in 2.5% increments. Heat treatment and subsequent tensile testing were designed to determine the limiting additions of chromium, manganese, and iron to the three base materials with respect to tensile properties, stability of the beta phase, and amenability to standard mill processing. Annealed strengths and moduli were found to increase with total eutectoid forming alloy content, and as molybdenum was substituted for vanadium in the base material. Strength and moduli also increased as the alloy element position in the periodic table became farther removed from titanium. All alloys examined were mechanically stable and exhibited yield strength to ultimate strength ratios greater than 0.90. Cold rollability requirements impose compositional limits on iron, particularly when added to base alloys containing molybdenum. Author

N63-15094 Battelle Memorial Inst., Columbus, Ohio
NOTCH SENSITIVITY OF REFRACTORY METALS First Quarterly Progress Report
H. R. Ogden Apr. 15, 1963 3 p 6 refs
(Contract AF 33(657)-10363)

Research on notch sensitivity of refractory metals includes: (1) the effect of a silicide coating on the transition behavior and fracture toughness of TZM and X110 metal sheets; (2) the determination of the effectiveness of oxygen on the impact properties of wrought tantalum and niobium; (3) the establishment of the strain-rate sensitivity of hydrogenated tantalum and niobium; and (4) crack propagation in refractory metals in terms of dislocation dynamics. I.v.L.

N63-15096 British Welding Research Assn., Research Station, Cambridge

INFLUENCE OF ALLOYING ELEMENTS ON THE CONTINUOUS COOLING TRANSFORMATION AND WELDABILITY OF BINARY AND TERNARY ALLOYS OF IRON, PARTS I AND II Final Technical Report, 1 Mar. 1961 to 28 Feb. 1962

May 1962 204 p 6 refs

(Contract DA-91-591-EUC-1719 and BWRA-C59)

Continuous cooling transformation diagrams have been determined for a series of vacuum-melted binary and ternary alloys of iron with carbon and other elements to determine the effect of different alloying elements on weldability. Data for the diagrams were determined by dilatometric studies. The microstructures of each sample studied are illustrated with electron microscope photographs. Bead-on-plate welding tests were made as a correlation of the dilatometric and microstructure data to the samples' weldability. An examination of cracking in these tests has shown that crack initiation always occurs in the martensitic regions of the heat-affected zone. An approximate relationship between heat-affected zone hardness and cracking has been established. Anomalous results occur, however, in regions where hard and soft microstructures coexist in the heat-affected zone and further work is necessary to explain this. R.C.M.

N63-15101 California U., Livermore. Lawrence Radiation Lab.

AN INVESTIGATION OF INTERSTITIAL SITES IN THE BCC LATTICE

Daniel N. Beshers Jan. 4, 1963 31 p 25 refs

(Contract W-7405-eng-48)

(UCRL-7184) OTS: $0.75

Two geometrically different positions are available in the body-centered cubic structure for the formation of interstitial solid solutions. In order to determine which of the two sites is energetically favored, relative values of the strain energy have been calculated for interstitial atoms of varying size. It is found that in some cases, notably in the group V-A elements, the tetrahedral rather than the octahedral sites are favored. Estimates of the energies of activation for diffusion based upon similar calculations of the associated strain energies are also presented. It is found that, in some cases, elementary diffusion jumps connecting tetrahedral sites are preferred to those linking octahedral positions. An analysis is also made of the relaxation strength associated with the tetrahedral position. It is found to be smaller than that associated with the octahedral position but sufficiently large to account for several measured values. Author

N63-15179 Armour Research Foundation, Chicago, Ill.

THE MECHANISM OF STRESS CORROSION IN STAINLESS STEELS Final Report, May 15, 1959 to May 15, 1960

Jacob M. Miller et al. AEC Div. of Tech. Inform., Sept. 1962 80 p

(ARF-2181-12) OTS: $2.00

The one major hazard of the austenitic steels for use in water-cooled nuclear reactors, i.e., stress-corrosion cracking is discussed and analyzed. General agreement on the experimental data obtained will permit more critical evaluation of the theories of the cracking mechanism. It is observed that: (1) The process of stress-corrosion cracking is a gradual one at all stages. (2) No specific chemical characteristics of the corrosion medium were established as essential to the failure process. (3) Simple exposure to the corrosion medium, without stress, produces no cracking tendency. (4) The appearance of a crack in the stainless steel is accompanied by the appearance of an anodic zone at the same site in the corroding surfaces. (5) The cracking process involves two stages: the first stage is stress-independent and quite short; however, the second is longer and more complicated. (6) The crack-propagation stage of the failure process forms a dimensionless fissure that agrees with the theory of Hoar and Hines. D.E.R.

N63-15191 HORIZONS INCORPORATED, Cleveland, Ohio

REINFORCEMENT OF NICKEL CHROMIUM ALLOYS WITH SAPPHIRE WHISKERS Interim Report No. 2, 29 Dec. 1962-28 Mar. 1963

Robert H. Kelsey Apr. 22, 1963 17 p

(Contract NOw-63-0138-c)

It has been shown that oxygen is required for the formation of a bond between iron and alumina whiskers. This oxygen may be introduced as naturally-occurring oxides on the surfaces of iron powder. Reinforcement has again been demonstrated in iron-alumina whisker composites subjected to short heating cycles. Evidence has been obtained that long heating cycles and excessive oxide content result in destructive attack on the alumina whiskers. Methods are projected for introducing the necessary oxygen by pretreating the whiskers. Author

N63-15199 Armour Research Foundation, Chicago, Ill.

DEVELOPMENT AND APPLICATION OF A THEORY FOR PLASTIC DEFORMATION OF CEMENTED ALLOYS. TASK I. COPPER-COOLED TUNGSTEN FIBER ROCKET NOZZLE MATERIALS Quarterly Report, Apr. 1 to June 30, 1962

N. M. Parikh July 25, 1962 11 p

(Contract DA-11-022-505-ORD-3092)

(WAL-TR-372/32-5, T-3)

The development of tungsten-silver alloys for use in rocket nozzles is reviewed. A method has been developed whereby the high-temperature strength of tungsten-silver composites is enhanced by improvement in the bond between tungsten fibers and powders. The process calls for much lower sintering temperatures. Impregnation with silver-lithium alloys helps eliminate porosity. I.v.L.

N63-15201 General Electric Co. Flight Propulsion Lab. Dept., Cincinnati, Ohio

HIGH-TEMPERATURE MATERIALS PROGRAM Progress Report No. 9, Part A

Mar. 30, 1962 66 p refs

(Contract AT(40-1)-2847)

(GEMP-9A) OTS: $1.75

High-temperature-materials research is reported as follows: fuel elements for operation in oxidizing atmospheres; reactor control materials; fabricability of structural materials; alloys; moderator fabrication and testing; and insulation materials. R.C.M.

N63-15215 Eigennössische Technische Hochschule, Zurich (Switzerland)

PHOTOELEKTRONISCHE ABTASTUNG CODIERTER BRIEFUMSCHLÄGE MITTELS CdS-PHOTOWIDERSTÄNDE [PHOTOELECTRONIC SCANNING OF CODED ENVELOPES BY MEANS OF CdS-PHOTORESISTANCE]

George Moschytz (Ph. D. Thesis) 1962 101 p refs In German (*Its* Prom 3164)

The development of a reading device for sorting coded postal check envelopes is reviewed. Specified coding procedure and recommended coding instructions point to the use of several small dimensional photoelectric cells for the scanning process. Results indicated that of all the cells investigated only cadmium sulfide photo resistance cells proved to be suitable. The behavior of this photo resistance was investigated by measuring techniques and in the light of its proposed application. Test results of these measuring techniques are presented along with the conclusions drawn from these results. The major components of the scanning model are described, and results of the code scanning by this model are presented. Trans. by I.v.L.

N63-15240 Massachusetts Inst. of Tech., Cambridge

STRUCTURAL AND MAGNETIC STUDIES BY NEUTRON DIFFRACTION Final Report, Sept. 1958-Dec. 31, 1961

David P. Shoemaker, Clara B. Shoemaker, John Mellor (Ph. D. Thesis), Leo G. Feinstein (M. S. Thesis–1962), Ronald J. Chandross (Ph. D. Thesis), William G. Sly, and Walter M. Meier Apr. 1, 1962 33 p refs
(Contract DA-19-020-ORD-4696)

Structural and magnetic studies by neutron and X-ray diffraction include: (1) the crystal structure of zinc cyanide; (2) ordering of the P-phase in a Mo-Ni-Cr crystal and ordering of the R-phase in a Mo-Co-Cr crystal; (3) X-ray diffraction studies of the delta phase of a Mo-Ni crystal and the determination of the crystal structure of the alloy; (4) atomic magnetic moments in B2 transition alloys: VFe, TiFe, and TiCo; and (5) a computer program for the IBM 709/7090 for determining odering parameters by means of least squares from data obtained by X-ray and neutron diffraction of powders, even under poor conditions of resolution. I.v.L.

19 MATERIALS, NONMETALLIC

Includes: mechanical and physical properties of non-metals (e.g., plastics).

For related information see: 07 Chemistry; 17 Machine Elements and Processes; 18 Materials, Metallic; 33 Stresses and Loads; and 34 Structural Design.

N63-14745 Bureau of Mines, Washington, D.C.
SYNTHESIS OF FIBROUS SILICON CARBIDE BY THERMAL REDUCTION OF SILICATES AND SILICON COMPOUNDS
John K. Alley, Robert C. Johnson, Charles Huggins, and H. R. Shell 1963 23 p 8 refs
(BMRI-6220)

Fibrous silicon carbide was produced by thermal decomposition of certain silicates contained in graphite crucibles. Induction heating was used to produce the necessary temperature and thermal gradients. Both green and white fibers were mainly the beta modification even though each color grew within a different temperature zone. Alpha silicon carbide, present in insufficient amounts for X-ray detection, was identified by electron diffraction. The white fibers formed in a zone between 1,365° and 1,634° C (± 50° C). The green fibers (less contaminated) formed in a much more narrow zone between 1,650° and 1,672° C (±50° C). The average lengths and widths of microscopic fibers grown by this method were 1.5 mm/0.002 mm (white) and 1.2 mm/0.0035 mm (green); however, some fibers observed by electron microscope had cross-sectional measurements of 150 to 300 A. Both differential thermal analysis and thermogravimetric analysis showed that silicon carbide fibers oxidized in air at temperatures above 500° C. Fibrous silicon carbide was indexed as a cubic cell with the dimensions $a = 4.358$ A. The density calculated from X-ray data was 3.217 g/cm^3. Author

N63-14810 Cryogenic Engineering Lab., National Bureau of Standards, Boulder, Colo.
A BIBLIOGRAPHY OF THE THERMOPHYSICAL PROPERTIES OF OXYGEN AT LOW TEMPERATURES
J. C. Hust, L. D. Wallace, J. A. Crim, L. A. Hall, and R. B. Stewart Feb. 1962 87 p 237 refs
(Supported by NASA)
(NBS-TN-137; PB-161638) OTS: $2.25

This bibliography of the mechanical, thermodynamic, and transport properties of oxygen below 0° C presents 325 references and is the result of a thorough search of the world's scientific and engineering literature. Listed for each reference are the properties and the corresponding temperature and pressure range, together with additional pertinent information such as the type of data (i.e., whether the data are derived from experimental measurements, theoretical considerations, or as a compilation from other sources), the form and amount of data, etc. An index according to property, subindexed for temperature and pressure ranges, and an author index are included. Author

N63-14838 Electrotechnical Lab., Tokyo (Japan)
A SURVEY OF THE EFFECT OF HEAT TREATMENT ON SILICON
Shun-ji Mori, Takashi Iizuka, and Kenkichi Tachikawa June 1962 90 p 74 refs In Japanese; English summary
(*Its* Circulars 152)

The effects of oxygen in silicon and germanium are presented with the following aspects of the subject being highlighted: resistivity changes by heat treatment; the effects on the lifetime and the backward characteristics of p-n junctions; the effect of oxygen on optical properties, mainly related to 9μ absorption; oxygen in molten silicon; solubility and diffusion constant of oxygen in silicon; effects of oxygen on etch pits formation; interaction of oxygen with acceptor impurities; energy level of oxygen; problems of oxygen in germanium; and a historical review of theoretical models with Kaiser's model explained in detail. A.R.B.

N63-14877 Armour Research Foundation, Chicago, Ill.
ULTRASONIC METHODS FOR NONDESTRUCTIVE EVALUATION OF CERAMIC COATING [Final Report, Mar. 1, 1961-Feb. 28, 1962]
K. E. Feith and W. E. Lawrie Wright-Patterson AFB, Ohio, Directorate of Materials and Processes, Feb. 1963 52 p 8 refs
(Contract AF 33(616)-6396)
(WADD-TR-61-91, Pt. II)

This report describes investigations into the use of ultrasonic techniques to determine the strength and integrity of ceramic-metal bonds. An acoustic image converter system was used successfully to obtain a television type display of ½₃₂-inch-diameter laminar defects in a zirconium oxide-inconel bond. The measured defect thickness varied between 300 and 500 microinches or about a factor of three greater than the average large grain in the coating material. Schlieren optical and acoustic lens techniques were used to visually investigate detailed properties of ultrasonic fields and the interaction of ultrasonic energy with a solid. The theory of Rayleigh waves was reviewed to provide a framework for experimental integrity determinations of ceramic coatings. Author

N63-14891 Little (Arthur D.) Inc., Cambridge, Mass.
INVESTIGATION OF THE THERMAL PROPERTIES OF HIGH-TEMPERATURE INSULATION MATERIALS Third Quarterly Progress Report [Nov. 1, 1962-Jan. 31, 1963]
Feb. 15, 1963 46 p 7 refs
(Contract AF 33(657)-9172)
(C-64694)

This report covers the experimental and theoretical work performed during the period 1 November 1962 to 31 January 1963. Included is a theoretical analysis of solid conduction in fibers of several arrangements and a discussion of the applicability of the analytical results to actual fiber systems. Data on the low-temperature thermal conductivity of graphite and zirconia fiber mats are given. Experimental measurements of the radiation transmission in the visible wavelength region are discussed, and data on several materials are presented. Data on the thermal conductivity at high temperatures of graphite fibers, graphite fibers and radiation shields, and zirconia fibers are reported. Author

N63-14956 Mellon Inst., Pittsburgh, Pa.
BALLISTIC PROTECTIVE BUOYANT MATERIALS Quarterly Report No. 7, July 1-Sept. 30, 1961

Michael C. Jaskowski [1962] 14 p
(Contract N140(138)68879B)

The effect of various surface finishes on the ballistic performance of 42 oz./yd.^{2} batts containing 1.0 dpf Orlon staple (3.0-in. cut) was investigated. The three finishes studied were the manufacturer's original antistatic agent, hydrophobed Aerogel and Decetex-104 silicone water-repellent. The ability of the batts to withstand fragment penetration increased as the fiber-to-fiber friction decreased. A comparison of the ballistics of two types of 1.5 dpf Dacron staples, hydrophobed, was obtained. Type 5400 (cut to 3.0-in. lengths) was vastly superior to Type 64 (cut to 2.5-in. lengths). A 50/50 blend of hydrophobed 0.5 dpf Acrilan (3.0-in. cut) and 1.5 dpf Dacron (Type 64-2.5-in.-cut) was found to be equal ballistically to a 50/50 composite of the same materials. Author

N63-15044 National Carbon Co., Parma, Ohio
RESEARCH AND DEVELOPMENT ON ADVANCED GRAPHITE MATERIALS. VOLUME VI—CREEP OF CARBONS AND GRAPHITES IN FLEXURE AT HIGH TEMPERATURES [Final Report]
E. J. Seldin Wright-Patterson AFB, Ohio, Directorate of Materials and Processes, June 1962 41 p 4 refs
(Contract AF 33(616)-691[E])
(WADD-TR-61-72, Vol. VI)

Flexural creep tests have been made on molded carbons and several types of graphites over the temperature range from 2200° to 3000° C. The amount of creep was found to decrease for a carbon as the temperature of graphitization increased, and as the holding time at graphitization temperature increased, for times up to four hours. Activation energies were determined for several standard and experimental grades of graphite from the steady-state creep rates. The activation energies ranged from 23 to 92 kcal/mole and appeared to be constant for each graphite. The flexure experiments demonstrated a marked dependence of the creep on the grain orientation for the more anisotropic graphites. The grain orientation showing the highest room-temperature strength shows the lowest high-temperature creep. Some of the factors which influenced the creep behavior are density, crystallite size, and the size, type, and orientation of the particles. Author

N63-15057 General Dynamics/Fort Worth, Tex.
INVESTIGATION OF COMBINED EFFECTS OF RADIATION AND VACUUM ON ENGINEERING MATERIALS. Second Quarterly Progress Report, Feb. 9-May 8, 1962
E. E. Kerlin and E. T. Smith June 4, 1962 116 p 43 refs
(NASA Contract NAS8-2450)
(FZK-147) OTS: $9.60 ph, $3.68 mf

The purpose of this experimental program is to measure the effects of the combined environment of nuclear radiation and high vacuum on a selected number of engineering materials. The environment is designed to approximate that which would be experienced by the component parts of a nuclear-powered spacecraft during the flight. The materials selected for testing are representative of those most likely to be used in a spacecraft of this type. The experiment will utilize two vacuum test chambers. Results are presented of the following investigations: radiation-induced gassing rates in certain organics; heat-transfer calculation in a vacuum environment; and calibration of the pilot model of the special weight-loss equipment. I.v.L.

N63-15060 Catholic U. of America, Washington, D.C.
AXIAL SHEAR VIBRATIONS OF STAR-SHAPED BARS—AN APPLICATION OF CONFORMAL TRANSFORMATION Technical Report No. 4
J. H. Baltrukonis, Kevin B. Casey, Michael Chi, and Patricio A. Laura Oct. 1962 31 p 7 refs
(NASA Grant NsG-125-61(Suppl 1-62))
OTS: $3.60 ph, $1.13 mf

The conformal transformation method is applied to the problem of calculating the natural frequencies of free, axial-shear vibrations of infinitely-long, prismatical bars with epitrochoidal cross sections. In the real plane, the boundary conditions are relatively complicated, but on conformal transformation of the cross section onto a unit circle, the boundary conditions become quite simple and can be identically satisfied. However, the governing differential equation becomes relatively complicated on transformation, and an exact solution is not possible. Two different collocation techniques are used to calculate approximate natural circular frequency coefficients for bars with free and clamped boundaries. The results are considered excellent, demonstrating remarkable agreement with previous calculations. Author

20 MATHEMATICS

Includes: calculation methods and theory; computers; data processing; and numerical analysis.

For related information see: 08 Communications; 09 Electronics; 10 Facilities; and 22 Navigation and Guidance.

N63-14721 Naval Weapons Lab. Computation and Analysis Lab., Dahlgren, Va.
TABLE OF EXPECTATIONS OF MEAN SQUARES IN THE ANALYSIS OF VARIANCE FOR CROSSED CLASSIFICATIONS
Klaus Abt Apr. 2, 1963 99 p 19 refs
(NWL-1833)

This report contains a table of the expectations of mean squares in the analysis of variance for crossed classifications and the description of the table. In an appendix, method is outlined which was used to obtain the mean square expectations. The table covers the two-way, the three-way, and the four-way classification with unequal but proportional as well as with equal cell numbers. The mean square expectations (and the appropriate variance ratios for testing all null hypotheses) are listed for all possible combinations of fixed and random effects classifications. Also, rules are given for generating the mean square expectations for all situations in the general case of an n-way crossed classification. Author

N63-14795 Stanford U. Applied Mathematics and Statistics Labs., Calif.
THE ASYMPTOTIC NORMALITY OF TWO TEST STATISTICS ASSOCIATED WITH THE TWO-SAMPLE PROBLEM
Saul Blumenthal Feb. 28, 1963 33 p 16 refs
(Contract Nonr-225(52); NSF Grant G-19126)
(Tech. Rept.-85)

The asymptotic normality of two statistics have been proved, they have been proposed to test the hypothesis that two samples come from the same parent population. One statistic is the number of runs of X's and Y's in the combined sample of X's and Y's; the other is the sum of squares of "S_i's" where S_i is the number of X's falling between the i^{th} and $(i-1)^{st}$ largest Y's. Both statistics have been studied previously, both lead to consistent tests, and both were known to be asymptotically normal under the null distribution. Here, limiting normality is proved under a fairly wide class of alternatives. The limiting power of these tests is also compared. The method used, a study of conditional moments, can also be used to prove limiting normality of "combinatorial" statistics of greater generality than the "sum of squares" statistic. Author

N63-14796 Stanford U. Applied Mathematics and Statistics Labs., Calif.
GENERALIZED LEAST SQUARES ESTIMATORS FOR RANDOMIZED FRACTIONAL REPLICATION DESIGNS

S. Zacks Mar. 15, 1963 30 p 11 refs
(Contract Nonr-225(52))
(Tech. Rept.-86)

Fractional replication designs are planned to attain information about some of the main effects and interactions affecting the operation of a missile with a relatively small number of trials. The statistical properties of the generalized least squares estimators for randomized fractional replications are then studied. It is proved that there is no generalized least squares estimator that yields estimates of the entire vector of 2^m parameters, but that there are generalized least squares estimators that estimate unbiasedly subvectors of parameters. The results hold true in more general factorial systems of order p^m (p greater than 2). D.E.R.

N63-14802 Illinois U. Coordinated Science Lab., Urbana
A PATTERN RECOGNITION COMPUTER USING ALL-MAGNETIC LOGIC
J. Divilbiss May 1962 159 p 15 refs
(Contract DA-36-039-SC-85122)
(R-141)

This thesis describes the development of a pattern-recognition computer consisting of a control computer and a pattern recognition unit (PRU). The role of the PRU in the combined system is analogous to that of the arithmetic unit in a conventional digital computer. The three principal divisions of the PRU are: (1) a two-dimensional shift register of N x N bits, (2) a k-word memory with N^2 bits per word, and (3) a bubbler consisting of N^2 bubble registers of length r. Each bubble register is a linear "self-ordering" register, that is, a register in which a fixed number of identical operations will order the information with all "ones" at one end of the register, all "zeros" at the other end. The control computer is of conventional design and is not treated at length. Examples of simple pattern recognition routines are given. A considerable part of the paper is devoted to developing a catalog of logical circuits using only transfluxors (multiaperture ferrite cores) and connecting wire. Certain aspects of the engineering design (as opposed to the logical design) of magnetic circuits are treated. In particular, it is shown both theoretically and experimentally that flux division in multiaperture magnetic devices is dependent upon the risetime of the setting current. Author

N63-14808 Michigan U. Inst. of Science and Tech., Ann Arbor
RESPONSE BIAS EXPLANATION OF WORD-FREQUENCY EFFECT
Daniel H. Carson Apr. 1963 9 p 2 refs
(Contract DA-36-039-SC-78801; Proj. Michigan)
(Memo. 2900-374-R)

In a test of an explanation of word-frequency effect, printed five-letter words with letter deletions simulating different noisy conditions were used. The results show that a response bias model denying stimuli any role accounts for practically all of the variance in the word-frequency effect at high noise levels. The model, however, is internally restricted, and its efficiency is artifactual. This new formulation is multiplicative instead of additive, and is no longer internally restricted. Author

N63-14826 North Carolina U., Chapel Hill
NEARLY OPTIMUM SPACINGS FOR ESTIMATING THE PARAMETERS OF THE GAMMA DISTRIBUTION Interim Technical Report No. 7
Carl-Erik Sarndal Dec. 1, 1962 21 p 3 refs
(Grant DA-ORD-7)
(AROD-2776-10)

The problem of estimating location and scale parameters of a distribution by a number of sample quantiles has been treated earlier. The present paper is concerned with estimation of α_1 and α_2 in the gamma distribution

$$\frac{1}{\alpha_2} f\left(\frac{z-\alpha_1}{\alpha_2}\right) = \frac{1}{\alpha_2^{\,r}\,(p)} \left(\frac{z-\alpha_1}{\alpha_2}\right)^{p-1} e^{-(z-\alpha_1)/\alpha_2}, \alpha_1 \leq z < \infty, \quad (1)$$

where p is assumed known. Important applications of the gamma distribution occur in lifetesting. For example, in studying objects with an exponentially distributed lifetime, the time to p-th failure (objects being replaced) has the density function (1). Author

N63-14863 Hanford Atomic Products Operation, Richland, Wash.
THE QUANTITATIVE ANALYSIS OF SETS OF MULTICOMPONENT TIME DEPENDENT SPECTRA FROM DECAY OF RADIONUCLIDES
W. L. Nicholson, J. E. Schlosser, and F. P. Brauer Dec. 1962 111 p 15 refs
(Contract AT(45-1)-1350)
(HW-75806) OTS: $2.25

A weighted least-squares method for estimating the contributions of individual radionuclides in a multicomponent pulse-height spectrum is described. The method is equally applicable for a set of spectra recorded over a period of time. The use of decay characteristics in addition to pulse-height characteristics increases the application and sensitivity of the method. A detailed description and listing is included of an IBM FORTRAN language program (suitable for a machine of memory capacity 32K) which performs the weighted least-squares estimation. As a degenerate case, the program performs the simultaneous linear equations estimation also. Examples are included of the application of the program to both actual pulse-height spectra and to Monte Carlo generated spectra. The data-processing system for transfer of punch-paper tape multichannel data to magnetic tape and for input-output to the quantitative analysis program is also described. Author

N63-14865 RAND Corp., Santa Monica, Calif.
PLANT MODERNIZATION UNDER CONDITIONS OF COMPETITION AND TECHNOLOGICAL IMPROVEMENT
R. Kalaba, A. Kent, and M. Prestrud Mar. 1963 43 p 9 refs
(Contract AF 49(638)-700; Proj. RAND)
(RM-3551-PR)

Two important aspects of plant modernization are (1) technological improvement and (2) plans of competitors for modernization of their plants. The purpose of this paper is to present a novel mathematical model of plant modernization in which both of these factors are considered. In addition to the basic equations themselves, a FORTRAN program for their resolution is given, and the results of some numerical experiments are presented. Author

N63-14866 Toronto U. Inst. of Aerophysics (Canada)
A NUMERICAL SOLUTION FOR THE FREE-MOLECULE IMPACT-PRESSURE PROBE RELATIONS FOR TUBES OF ARBITRARY LENGTH
J. H. de Leeuw and D. E. Rothe Dec. 1962 59 p 9 refs
(Contract AF-AFOSR-62-98; Defence Res. Bd. Grant 9551-02)
(UTIA-88)

A numerical analysis was made of the free-molecule impact-pressure probe relations for circular tubes at zero angle-of-attack. A computer program was written, and the calculations were carried out by an IBM-650 electronic computer for specific speed ratios in the range between zero and twenty, and for tube geometries varying from an orifice to an infinitely long tube. Graphs and data are presented. Author

N63-14867 Lockheed Missiles and Space Co., Sunnyvale, Calif.
MODULAR ARITHMETIC TECHNIQUES [Final Report, July 1, 1961-Oct. 31, 1962]

E. N. Belland, Y. A. Keir, R. D. Merrill, N. S. Szabo, R. I. Tanaka, and M. Tannenbaum Wright-Patterson AFB, Ohio. Electronic Technology Lab., Jan. 1963 237 p 21 refs
(Contract AF 33(616)-7326)
(Rept. 2-38-62-1; ASD-TDR-62-686)

This report describes the results of the second year of a two-year study on the applications of residue or modular number systems to digital computers. Such number systems, because of their carry-free characteristics, offer the possibility of high speed in executing arithmetic operations. The discussion places special emphasis on the general case. Limitations of residue systems are explored. Algorithms for sign determination, division overflow detection, and magnitude of overflow determination are described. Different organizations and logical mechanizations are discussed and compared. The report also discusses the concept of a special-purpose residue computer for real-time applications. The results of an experimental investigation of binary-to-residue code conversion are presented. Author

N63-14898 Sandia Corp., Albuquerque, N. Mex.
TABLES OF ROOTS OF THE FIRST TEN THOUSAND INTEGERS
C. B. Bailey and G. E. Reis Jan. 1963 236 p 2 refs
(SCR-501) OTS: $3.00

To avoid the calculation of roots when using desk calculators, a reference table is presented for: square roots of N and 10N, cube roots of N, 10N and 100N, and fourth roots of N, 10N, 100N and 1000N for the first 10,000 integer values of N to 9 decimal places; the first ten integer roots of the first 1000 integers; and the first ten integer roots of functions of e, π and γ. A.R.B.

N63-14945 Wisconsin U., Madison
ON ONE DIMENSIONAL HYDROMAGNETIC FLOW WITH TRANSVERSE MAGNETIC FIELD. PART I: SIMPLE WAVE FLOW. PART 2: FLOW IN A CHANNEL WITH SMALL AREA VARIATIONS Technical Summary Report
Roy M. Gundersen Oct. 1961 8 p 3 refs
(Contract DA-11-022-ORD-2059)
(MRC-269)

One-dimensional hydromagnetic flow with a transverse magnetic field is mathematically analyzed for both the case of simple wave flow and flow in a channel with small area variations. The results obtained make it possible to extend the work on ordinary gas flow to hydromagnetic flow. D.E.R.

N63-14954 Stanford Research Inst., Menlo Park, Calif.
THE KNOWLEDGEABLE ANALYST: AN APPROACH TO STRUCTURING MAN-MACHINE SYSTEMS
K. H. Schaeffer, John B. Fink, Maurice Rappaport, Leonard Wainstein, and Charles J. Erickson Feb. 1963 135 p refs
[Contract AF 49(638)-1020]
(AFOSR-4490)

In an attempt to evolve a general method for systems analysis, the matrix-network approach for the analysis of complex man-machine systems is presented. This approach consists of seven steps which show how a system can be structured and how mathematical models of systems aspects can be incorporated into the overall analysis. However, some of these steps involve, besides formal rules, the judgment of a knowledgeable analyst. To delve deeper into this judgment function, various logical, methodological, and psychological aspects concerning this function are discussed by different authors. On the basis of these discussions, the principal author develops requirements which must be met by successful approaches to the structuring of complex systems. Author

N63-14958 Pacific Missile Range, Point Mugu, Calif.
ANALYSIS OF RECOVERY ZONE FOR MA-7 AND MA-8 FLIGHTS IN MERCURY PROGRAM
C. E. Parker and M. L. Eaton Apr. 17, 1963 15 p 9 refs
(PMR-TM-63-3)

In assistance to the Atlantic Missile Range, a mathematical method devised by the Pacific Missile Range was applied to flights in the Mercury program in an attempt to improve the prognostication of recovery zones for satellite capsules returned from orbit about the earth. Using the general mathematical model described herein, the computer generates a sample of random points from the density of uncertainty of prediction of the splash point, when this uncertainty results principally from random errors in the dynamic characteristics of the retrorocket phase of the trajectory. From this sample, confidence regions are developed which can be used to indicate the area over which a capsule-recovery task force should be deployed. Post-mortem calculations for the MA-7 flight from data on the MA-4, MA-5, MA-6, and MA-7 flights, based on a sample of 500 random points, resulted in an elongated, narrow V-shaped distribution along the ground track of the orbit, with 95 percent of the points within 660 nautical miles down-range from the nominal splash point and the center of gravity of the points 136 nautical miles down-range from the nominal splash point. The actual splash point of the MA-7 capsule was 250 nautical miles down-range from the nominal splash point. *A-priori* calculations for the MA-8 flight, from data on the MA-4, MA-5, MA-6, and MA-7 flights, based on a sample of 499 random points, resulted in a more eastward orientation of the ground track and a distribution similar in shape to that for the MA-7 flight, with 95 percent of the points within 505 nautical miles down-range from the nominal splash point and the center of gravity of the points 130 nautical miles down-range from the nominal splash point. The actual splash point of the MA-8 capsule was very close to the nominal splash point. Author

N63-14962 Los Alamos Scientific Lab., N. Mex.
A METHOD FOR EULERIAN FLUID DYNAMICS
Marvin Rich Mar. 29, 1963 96 p 6 refs
(Contract W-7405-ENG-36)
(LAMS-2826) OTS: $2.25

A method is presented for obtaining numerical solutions of the Eulerian hydrodynamic equations for supersonic compressible flows. The procedure is an adaptation of the PIC method to the case of a continuous fluid. Some discussion is given concerning the limitations of the procedure; the conservation of mass, energy, and momentum; and the treatment of rigid obstacles and two-fluid interfaces. Examples of calculations for flows past a number of cylindrically symmetric objects are also presented. Author

N63-14965 Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge
APPLICATION OF STOCHASTIC APPROXIMATION METHODS TO SYSTEM OPTIMIZATION
David J. Sakrison (Ph. D. Thesis) July 10, 1962 78 p 13 refs
(Contracts DA-36-039-sc-78108 and DA-SIG-36-039-61-G14)
(MIT-TR-391)

This report is concerned with systems whose form is fixed (either by physical limitations or by the choice of the system designer), but which contain a number of variable parameters. The system input, v(t), is a sample function from a stationary ergodic random process; corresponding to v(t) there is another ergodic random process, d(t), which represents the desired output for the system. The problem of interest is how to find the setting of the variable parameters which causes the actual system output, q(t), to resemble most closely (in some desired sense) the desired output, d(t). An iterative method of solution is considered here. That is, a sequence of parameter settings is generated by selecting an

initial setting and then alternately observing the system performance and altering the parameter setting. For such an approach to be useful, it must be possible to show *a priori* that this sequence of parameter settings converges in some meaningful sense to the setting that optimizes the system performance. We consider a particular iterative adjustment procedure and prove that, for certain forms of systems and under certain reasonable conditions on the random processes, the sequence of parameter settings generated by the adjustment procedure does converge to the optimum setting in the mean-square sense. Author

N63-14977 Union Carbide Nuclear Co., Oak Ridge, Tenn.
CUBIC SPLINE, A CURVE FITTING ROUTINE
A. H. Fowler and C. W. Wilson Apr. 12, 1963 74 p 3 refs
(Contract W-7405-eng-26)
(Y-1400) OTS: $2.00

A method of mathematically fitting a curve through a given ordered set of points has been developed and programed in FORTRAN computer language. The fitted cuve, which is made up of a series of normalized cubic polynomials, very nearly approximates the curve generated by passing an infinitely thin spline through the sets of points and is, therefore, called a "cubic spline." The curve has the properties of continuous position, slope, and curvature. The restraints placed upon the cubic spline may be relaxed by applying an additional feature which permits the points to be adjusted by, at most, some preset value. This has the effect of smoothing the curve in the sense that it reduces the strain energy stored in it while preserving the general shape of the curve. Tool centers for numerically controlled tools may be found with the interpolation and offsetting methods included. Author

N63-14982 Lockheed Missiles and Space Co., Sunnyvale, Calif.
ERROR PROPAGATION IN AEROSPACE SYSTEMS: A SELECTIVE ANNOTATED BIBLIOGRAPHY
J. L. Burroughs, E. E. Graziano, and W. W. Happ (comps.) Oct. 1962 88 p 226 refs
(SB-62-50)

The error propagation problem can be approached by present mathematical techniques in several ways. Some of the more commonly used approaches to this problem are: (1) to treat uncertain variables as normally distributed random variables, and to find the distribution of system performance variables by linear perturbation techniques; (2) to treat uncertain variables as nonnormally distributed random variables, and to find the distribution of system-performance variables by the use of change of variable techniques, probabilistic algebra, or high-order perturbation techniques; (3) to treat uncertain signals and parameters as variables which are constrained to satisfy a set of equalities and inequalities, and to find the bounds on the errors of system-performance variables by mathematical (linear and nonlinear) programing techniques; and (4) to simulate uncertain variables and system dynamics on a computer so that the distributions of system-performance variables can be obtained by Monte Carlo techniques. The advantages and limitations of these and other methods of analyzing system accuracy, as well as examples of their application to specific aerospace systems, are treated in the references which are contained in this selected bibliography. Author

N63-14992 Lincoln Lab., Mass. Inst. of Tech., Lexington
THE COBI DATA TRANSMISSION MODEM
K. H. Morey May 23, 1962 61 p
(Contract AF 19(604)-7400)
(Tech. Rept. 263)

The COBI (coded biphase) data transmission modem employs phase-reversal modulation and code translation as a means of transmitting serial digital data over voice-bandwidth telephone circuits. The use of phase-reversal modulation gives COBI certain advantages over present amplitude-modulation systems, including the ability to function with lower error rates in the presence of rapid signal-strength fluctuations and larger amounts of Gaussian and impulse noise. Code translation makes it possible to include block-start and bit-timing information in the data stream. This report is primarily a detailed description of COBI and the manner in which it operates. Background is provided by a history of data systems leading to COBI, a brief discussion of telephone-circuit characteristics, and a summary of the theory basic to phase-reversal modulation. The report also describes the extensive tests to which COBI has been subjected and presents some of the results. Specifications for a COBI modem, as well as procedures for its alignment and testing, are appended. Author

N63-15027 Southwest Research Inst., San Antonio, Tex.
FURTHER DEVELOPMENT OF A MORE ACCURATE METHOD FOR CALCULATING BODY-WATER IMPACT PRESSURES Technical Report No. 5
Wen-Hwa Chu and David R. Falconer Jan. 1963 80 p 12 refs
(Contract Nonr-2729(00))

A computer program for two-dimensional slamming of a Mariner section is discussed. The program was devised to examine the practical applicability of a previously described numerical method, and to gain insight for future development of a numerical scheme should additional effort appear valuable. A discussion of this effort and the implications for the future are given. Author

N63-15040 Michigan U. Coll. of Engineering, Ann Arbor
STUDIES IN NONLINEAR MODELING-V: NONLINEAR MODELING FUNCTIONS OF A SPECIAL TYPE Scientific Report No. 2
Otto George Ruehr (Ph. D. Thesis) Aug. 1962 110 p 11 refs
(Contracts AF 19(604)-6655, AF 19(604)-4993, and AF 19(604)-7428)
(Rept. 3648-5-T; AFCRL-62-573)

This paper discusses the nonlinear modeling of three types of partial differential equations in n variables, elliptic, parabolic, and hyperbolic. The modeling functions are restricted to depend only on the (measured) dependent variable and not on the coordinates. For the scalar wave equation (elliptic) and the diffusion equation (parabolic), it is found that the allowable modeling functions must satisfy a particular n'th-order nonlinear ordinary differential equation. A simple counter-example shows that similar restrictions do not hold for the time-dependent wave equation (hyperbolic). The sets of allowable modeling functions corresponding to the wave and diffusion equations are shown to be identical to those obtained by modeling certain second-order linear ordinary differential equations. The problem of similitude restrictions is interpreted as the study of certain polynomials generated by Bürmann series expansions. The limiting behavior of these polynomials is obtained in special cases. Author

N63-15047 Oak Ridge National Lab., Tenn.
MATHEMATICS DIVISION Annual Progress Report For Period Ending December 31, 1962
A. A. Grau et al Apr. 17, 1963 63 p refs
(Contract W-7405-eng-26)
(ORNL-3423) OTS: $1.75

Mathematical research is presented for the following areas: numerical analysis; medical and biological statistics; programing and analysis for: chemistry, physics (including health physics and neutron physics), information retrieval, inspection engineering, metals and ceramics, reactor chemistry, reactors, special subroutines, agriculture, systems, and computer operations. R.C.M.

N63-15049 European Atomic Energy Community, Brussels (Belgium)

PROPRIETES DES POLYNOMES ASSOCIES AUX FONCTIONS DE LAGUERRE DE SECONDE ESPECE GENERALISEES ET QUESTIONS CONNEXES [PROPERTIES OF POLYNOMIALS ASSOCIATED TO GENERALIZED SECOND-SPECIES LAGUERRE'S FUNCTIONS AND RELATED QUESTIONS]

R. F. Gloden Joint Nuclear Research Center, Ispra Establishment (Italy), Scientific Information Processing Center–CETIS. [Feb.] 1963 8 p Presented at the Intern. Congr. of Mathematicians, Stockholm 15–22 Aug. 1962 In French; English summary

(CETIS-58; EUR-207.f) Available from Belgian American Bank and Trust Co., N.Y., account No. 121.86: 25 Belg. Fr.

Utilizing the recurrence formulae for the terms of the approximants of the J fractions, the recurrence formula for the generalized Laguerre polynomials is recomputed, and that for the associated polynomials is established. The properties of the polynomials $K_n\beta(x)$ are then established from the Laguerre equation by means of a transformation of the Wronskian associated with that equation. These polynomials satisfy one differential equation of the second order and another of the fourth order, and the general integral of this last equation is studied. Author

N63-15103 Knolls Atomic Power Lab., Schenectady, N.Y.

K A R E: A SYSTEM OF DIFFUSION THEORY PROGRAMS FOR THE PHILCO 2000. VOLUME I: GENERAL DESCRIPTION, INPUT INSTRUCTIONS, AND OUTPUT DETAILS

J. A. Archibald, Jr., and H. L. Teaford Nov. 20, 1962 244 p 53 refs

(Contract W-31-109-eng-52)

(KAPL-2165-1) OTS: $3.50

The present KARE system provides semiautomatic calculations of neutron group constants, criticality, spatial distribution of neutron fluxes and fission sources, fuel and poison depletion, and lumped fission-fragment poisoning effects throughout life. KARE also includes a multichannel flux-synthesis calculation, perturbation calculations, a calculation of gamma radiations, and a calculation of space- and spectrum-dependent thermal fluxes. This volume contains a general technical description of the entire system and a detailed description of the input and output. Author

N63-15151 Boeing Co. Aero-Space Div., Seattle, Wash.

PROTON FLUXES ALONG TRAJECTORIES THROUGH THE INNER VAN ALLEN BELT

F. C. Perry *In* Atomic Energy Commission. Div. of Tech. Inform., Wash., D. C. Protection Against Radiation Hazards in Space Proc. of the Symp. at Gatlinburg, Tenn., Nov. 5–7, 1962 p 725–738 17 refs (See N63-15138 11-28) OTS: $7.00

A method is formulated to calculate, by means of high-speed digital computing equipment, the total time-integrated proton flux for an arbitrary trajectory through the inner Van Allen belt. To this end, a map of the inner-belt proton flux has been prepared in the (B,L) coordinate system, where B is computed from the 48-term spherical harmonic expansion of the earth's magnetic potential due to Finch and Leaton and L is the McIlwain parameter. This map is feasible, since the high-energy trapped proton component is generally quite stable with respect to geomagnetic activity. Author

N63-15190 Polytechnic Inst. of Brooklyn. Microwave Research Inst., N.Y.

THE MATRIX MANIPULATION OF BILINEAR TRANSFORMATIONS

H. M. Altschuler Apr. 9, 1963 15 p 17 refs

(Grant AF-AFOSR-62-295)

(PIBMRI-1137-63)

The matrix character of bilinear transformations is explored, "bilinear matrices" are described, and the rules which govern their use are established. Bilinear matrices find their application in simplifying many manipulations which involve bilinear transformations. Several simple examples of such applications are given and short tables of bilinear matrices pertinent to microwave networks are included. Author

N63-15207 Federal Aviation Agency. Systems Research and Development Service, Atlantic City, N.J.

COMPUTER PROGRAMMING OF PHASE I MASTER PROGRAM. VOLUMES I, II, AND III: TEXT AND APPENDIX XXI Final Report

Don W. Vogel, Kenneth W. House, William Brown, Raymond J. Hilton, and Robert B. Stein June 1962 515 p

The master program for Phase I flight-data processing was developed to provide the maximum benefits for the Phase I systems. It permits the computer to accept and process six different kinds of messages, thus providing the system with the capability of processing semiautomatically any flight-plan message received in the prescribed format. The resultant output of the program provides the Air Route Traffic Control Center with printed flight-progress strips and the automatic transmission of flight-plan estimates to other computer-equipped centers. The outputs are time-controlled by the use of a real-time digital computer clock. The program is capable of handling airway routes and four types of direct routes, and will accept modification messages reflecting data or route changes. In addition, provisions are made for the integration of a controller update program to implement the controller updating equipment. Author

N63-15220 Los Alamos Scientific Lab., N. Mex.

ANISOTROPIC SCATTERING IN THE TRANSPORT EQUATION: AN EVALUATION OF COMMON APPROXIMATIONS

K. D. Lathrop Apr. 10, 1963 36 p 7 refs

(Contract W-7405-eng-36)

(LAMS-2873) OTS $0.75

In the monoenergetic transport equation, the infinite-medium diffusion length is calculated for ratios of the mean number of secondaries per collision less than unity. The diffusion length is calculated using several common approximations to scattering laws which attempt to account for anisotropic scattering. Results of these calculations are compared to direct solutions of the transport equation obtained using the exact scattering law for elastic scattering by hydrogen and a three-term expansion in inverse powers of the atom mass for deuterium elastic scattering. In addition to common anisotropic scattering approximations, a step-function approximation is developed and examined. For calculating the infinite-medium diffusion length, the accuracy of approximation is found to be, in order of increasing accuracy, (a) isotropic approximation, (b) transport approximation, (c) forward-backward approximation, (d) extended transport approximation, (e) P_3 approximation, and (f) higher N P_N approximations. For hydrogen elastic scattering, a single step function approximation is found to rank between (d) and (e) in accuracy, and a double step function approximation is found to be nearly as accurate as (e). Author

N63-15221 North Carolina State Coll. School of Physical Sciences and Applied Mathematics, Raleigh

DUAL SERIES RELATIONS

Ian N. Sneddon (Glasgow U.) Mar. 1963 85 p 21 refs A series of lectures given at N. Carolina State Coll., Mar. 1963

(Contract AF 49(638)-1159)

(PSR-13/1)

Results of recent research on dual series relations in mathematical physics are discussed. The dual relations involving the following series are developed: (1) Fourier-Bessel series, (2) Dini

series, (3) sine series, (4) cosine series, (5) series of associated Legrendre functions, and (6) dual equations involving series of Jacobi polynomials. Results of the research reported have been successfully applied to the solution of certain crack problems in the mathematical theory of elasticity. M.P.G.

N63-15225 Rocketdyne, Canoga Park, Calif.
NEW TABLES OF THE NONCENTRAL *T* DISTRIBUTION
M. O. Locks, M. J. Alexander, and B. J. Byars Wright-Patterson AFB, Ohio, Aeronautical Res. Labs., Jan. 1963 470 p 10 refs
(Contract AF 33(616)-7372)
(ARL-63-19)

This monograph presents new tables of the probability densities and cumulative probabilities of the noncentral t distribution. These tabulations differ from existing ones primarily in the treatment of the range of values for the noncentrality parameter δ. Values of the distribution are given for both $\delta = K_p(f+1)^{1/2}$ and $\delta = K_p(f+2)^{1/2}$ where K_p is the normal deviate corresponding to probability and f is the degrees of freedom. The distribution functions are given in two different sets of tables: (1) the probability integrals (cumulative probabilities associated with many values of the noncentral t statistic), and (2) percentage points (values of t associated with relatively few fixed probability levels). Author

21 METEOROLOGY

Includes: climatology; weather forecasting; lower atmosphere studies; and oceanography.

For related information see: 05 Astronomy and Astrophysics; 12 Geophysics; and 29 Space Sciences.

N63-14764 Hokkaido U. Inst. of Low Temperature Science, Sapporo (Japan)
HYDROGRAPHY OF THE ARCTIC OCEAN WITH SPECIAL REFERENCE TO THE BEAUFORT SEA
Kou Kusunoki 1962 78 p 48 refs Published as *its* Contribution, Ser. A, no. 17 p 1–74)
(Its Contribution 628)

Data on arctic oceanography are presented, with special reference to the central part of the Arctic Ocean. Included are: background of the oceanographical studies in the Arctic Ocean and a general account of the ice islands, observations at ice island T-3 in 1959 to 1960, temperature distribution tables, chlorinity and density tables, chemical elements distribution tables, and water masses and circulation in the Arctic Ocean. D.E.R.

N63-14825 Bollay (E.) Associates, Inc., Santa Barbara, Calif.
ECONOMIC IMPACT OF WEATHER INFORMATION ON AVIATION OPERATIONS Final Report
Washington, Federal Aviation Agency. Systems Research and Development Service, Sept. 30, 1962 360 p refs
(Contract FAA/BRD-410)

The Administrator of the Federal Aviation Agency is charged with the responsibility of assuring the safe and efficient utilization of the nation's airspace. Weather affects both safety and efficiency, and a reduction of its harmful influences is an important matter of concern to the Agency. The Agency has determined the weather information required by all airspace users during the period from the present through 1975 to produce the maximum possible reduction in weather effects upon the users operations, and is now designing the Common Aviation Weather System (CAWS) to provide the needed information. The implementation of this system will involve the expenditure of additional funds above that presently devoted to aviation weather support. It is the purpose of this study to weigh the benefits to be derived from the CAWS against the additional costs involved and, in so doing, to provide an objective means of comparing the returns to be received from such expenditures with those which might result from expenditures for other aviation support functions. Benefit-to-cost ratios were determined in two ways. The first method computes the ratio of the present value of total benefits, through 1975, with present value of total costs; this yields a ratio of 2 to 1. In the second method, an annual benefit/cost ratio is computed for the 1970-75 time period. This ratio, which reflects conditions after CAWS implementation is complete, is 3 to 1. Author

N63-14914 Wisconsin U., Madison
EMPIRICAL AND THEORETICAL STUDIES OF ATMOSPHERIC ENERGETICS Annual Report
Elford G. Astling, Reid A. Bryson, R. J. Deland, John A. Dutton, D. R. Johnson, W. Schwerdtfeger, and Lyle H. Horn Sept. 15, 1962 121 p 65 refs
(Contract CWB-10240)

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6. A STUDY OF THE MOVEMENT OF LONG ATMOSPHERIC WAVES R. J. Deland p 100–114 2 refs (See N63-14920 11-21)

N63-14915 Wisconsin U., Madison
AN ANALYSIS OF THE GEOSTROPHIC KINETIC ENERGY SPECTRUM OF LARGE-SCALE ATMOSPHERIC TURBULENCE
Lyle H. Horn and Reid A. Bryson *In its* Empirical and Theoretical Studies of Atmospheric Energetics Annual Report Sept. 15, 1962 p 1–16 16 refs (See N63-14914 11-21)

The mean geostrophic kinetic-energy spectrums of the large-scale atmospheric circulation features are presented for a six-month winter period at three elevations and three latitudes. The mean spectrums are partitioned into two sections, and an $n^{-5/3}$ power relationship is noted between geostrophic kinetic energy and wavelength for the higher wave numbers. The physical significance of the partitioning and of the $-5/3$ relationship is considered by comparing these results with the results obtained from other investigations of atmospheric energy processes. Certain comparisons indicate that the wavelengths described by the $-5/3$ power relationship are those for which the two-dimensional turbulence is isotropic. Other comparisons suggest that these same wavelengths are those at which the kinetic energy of the atmosphere is produced. Author

N63-14916 Wisconsin U., Madison
ON THE MAINTENANCE OF THE SOUTHERN CIRCUMPOLAR VORTEX

W. Schwerdtfeger *In its* Empirical and Theoretical Studies of Atmospheric Energetics Annual Report Sept. 15, 1962 p 17–18 (See N63-14914 11-21)

An introduction is presented on the maintenance of the southern circumpolar vortex by the production of available potential energy through differential meridional heating and its conversion into kinetic energy. I.v.L.

N63-14917 Wisconsin U., Madison

THE SOUTHERN CIRCUMPOLAR VORTEX AND THE SPRING WARMING OF THE POLAR STRATOSPHERE

W. Schwerdtfeger *In its* Empirical and Theoretical Studies of Atmospheric Energetics Annual Report Sept. 15, 1962 p 19–44 20 refs Presented at the Intern. Symp. on Stratospheric and Mesopheric Circulation, Berlin, Aug. 1962 (See N63-14914 11-21)

The yearly march of the meridional temperature differences between middle and polar latitudes of the southern hemisphere shows a predominance of the annual component at the surface and in the stratosphere, and of the semiannual in the troposphere. An examination of the various terms in the heat budget of the troposphere leads to the conclusion that the absorption of incoming solar radiation is the only term which has meridional differences with a stronger semiannual than annual variation, and with the proper phase. An estimate of the efficiency of this type of differential heating indicates that its magnitude is large enough to account for the observed yearly march of the meridional tropospheric temperature gradient. This semiannual periodicity also contributes to the seasonal change of the strength of the stratospheric circumpolar vortex which attains its maximum, at least up to the 50-mb level, in September. The differential heating by absorption of solar radiation is thus considered the forcing factor which tends to reestablish the pole-centered vortex after cyclonic developments in the strong circumpolar westerlies have disturbed its nearly circular symmetric features. Only after the September peak does the efficiency of this process decrease significantly.

Author

N63-14918 Wisconsin U., Madison

THE RELATION BETWEEN ATMOSPHERIC ENTROPY AND AVAILABLE POTENTIAL ENERGY

John A. Dutton *In its* Empirical and Theoretical Studies of Atmospheric Energetics Annual Report Sept. 15, 1962 p 45–69 7 refs (See N63-14914 11-21)

It is shown that available potential energy represents the amount of gravitational potential energy which must be expended to bring the isobars and isentropes to their average height, and thus produce a pressure and potential temperature distribution with only vertical variation. An expression is derived from this definition. The reference state of the atmosphere specified by this definition possesses the maximum entropy on every horizontal surface which can be obtained by isentropic processes that do not change the average height distribution of potential temperature. The amount of available potential energy is therefore expressed as a weighted average of the difference in local entropies between an actual and the reference state of the atmosphere. Author

N63-14919 Wisconsin U., Madison

A STUDY OF TERRESTRIAL RADIATION MEASURED BY TIROS II

Elford G. Astling and Lyle H. Horn *In its* Empirical and Theoretical Studies of Atmospheric Energetics Annual Report Sept. 15, 1962 p 70–99 20 refs (See N63-14914 11-21)

Mean meridional and latitudinal profiles of outgoing long-wave radiation as measured by Tiros II from 50° S to 50° N for 27 days during the period November 26, 1960 to January, 1961, were prepared and studied. High values of outgoing radiation were found over cloudless subtropical regions and low values over higher latitudes and over cloudy equatorial regions. The land areas in the summer hemisphere had higher values of outgoing radiation than land areas in the winter hemisphere. Over the oceanic areas, the values were more uniform between the summer and winter hemispheres. By extrapolating the mean meridional profile of outgoing radiation to the poles, it was possible to compute an albedo of .38. A partitioning of the data revealed the effect of limb darkening and its apparent dependence on latitude. Author

N63-14920 Wisconsin U., Madison

A STUDY OF THE MOVEMENT OF LONG ATMOSPHERIC WAVES

R. J. Deland *In its* Empirical and Theoretical Studies of Atmospheric Energetics Annual Report Sept. 15, 1962 p 100–114 2 refs (See N63-14914 11-21)

The day-to-day changes of phase of the zonal Fourier harmonics of the 500-mb height are analyzed for six months of data. Since the phase changes are equivalent to movement of long waves, the wave speeds computed from the phase changes may be compared with the speed of Rossby waves of corresponding wavelength. Good agreement is noted for wave numbers 4 to 10, while the long waves corresponding to wave numbers 1 through 3 remain quasi-stationary. Author

N63-15042 Canterbury U., Christchurch, (N. Zealand)

THE DISTRIBUTION OF METEORS AROUND THE EARTH'S ORBIT

C. S. L. Keay Feb. 18, 1963 30 p 22 refs Submitted for Publication

(NASA Grant NsG-219-62)

OTS: $2.60 ph, $1.10 mf

As a result of a 69.5 mc/s radar survey of meteoric activity, recently undertaken in New Zealand, the variation of incident flux with solar longitude has been determined. It has been confirmed that the spatial density of small-size (sixth magnitude) meteoric matter is greater along the earth's orbit during the latter half of the year. However, the comparison of results from both hemispheres shows that, at midlatitude observing stations, this asymmetry has a smaller influence than the gyrations of the ecliptic on the seasonal variation in observed meteor rate. These effects provide a satisfactory explanation for most of the differences between the results from the two hemispheres. Author

N63-15178 Hawaii Inst. of Geophysics, Honolulu

SOME ASPECTS OF THE METEOROLOGY OF THE TROPICAL PACIFIC VIEWED FROM AN ATOLL Scientific Report No. 5

Ronald L. Lavoie Jan. 1963 84 p 32 refs

(Contract AF 19(604)-7229)

(Hawaii Inst. Geophys. Rept.-27; AFCRL-63-235)

A detailed climatological study of surface and upper-air data from Eniwetok Atoll was carried out in order to solve various tropical oceanic problems including island influence, diurnal variations, and the nature of synoptic disturbances. Among results of the analysis are: (1) the atoll influence upon cloud or precipitation over the atoll itself is hardly detectable and probably insignificant; (2) the diurnal variation of the surface wind is almost exclusively the result of worldwide, atmospheric tidal motions, except for a possible speed increase of less than 0.1 kt near mid-day; (3) low cloudiness shows a diurnal variation whose range is less than 4% of total sky with maximum cover at 0700 local time; (4) precipitation occurrence shows a distinct early morning maximum; (5) in synoptic disturbances affecting the region, equatorward flow gives rise to a slight tendency for better-than-normal weather while poleward flow is associated with markedly wetter weather; (6) disturbances which make themselves felt primarily in the wind-speed field appear to contribute significantly to bad weather periods at Eniwetok. Author

N63-15242 Weapons Research Establishment (Australia)
A REVIEW OF THE PUBLISHED LITERATURE ON THE OZONOSPHERE
B. G. Hunt June 1961 44 p 74 refs
(Tech. Note SAD-79)

This review attempts to summarize the salient points made in the very extensive literature which exists on ozone in the atmosphere. Methods of measurement, variations of atmospheric ozone, temperature variations of the ozone layer, theories of the formation of ozone, and the influence of ozone on the radiation balance of the earth are discussed. Author

22 NAVIGATION AND GUIDANCE

Includes: autopilots; star tracking; inertial platforms; and traffic control.

For related information see: 06 Auxiliary Systems; 08 Communications; 09 Electronics; 10 Facilities; 15 Instrumentation; 20 Mathematics; and 29 Space Sciences.

N63-14754 General Precision, Inc., Tarrytown, N.Y.
STUDY OF MULTI-FUNCTION SENSORS FOR GUIDANCE SUBSYSTEMS Second Quarterly Technical Note [Oct. 1-Dec. 31, 1962]
Alan Bloch Wright-Patterson AFB, Ohio, Aeronautical Systems Div., Apr. 1963 40 p refs
(Contract AF 33(657)-9207)

The purpose of the program detailed herein is the ultimate development of multifunction sensors for space-vehicle guidance and navigation. This second quarterly report contains detailed discussions of the work carried out during the reporting period. A section is devoted to the theory of Fresnel zone plates. Author

N63-14803 Michigan U. Inst. of Science and Tech., Ann Arbor
STUDY AND ANALYSIS OF SELECTED LONG-DISTANCE NAVIGATION TECHNIQUES, VOLUME I: SUMMARY Final Report [Sept. 21, 1961-July 31, 1962]
James O'Day, Irvin Sattinger, Robert Scott, and Joseph Sullivan Dec. 1962 39 p 3 refs
(Contract ARDS-436)
(Rept. 4761-10-F(I))

The state-of-the-art and the development potential of heading references, VLF radio systems, inertial techniques, and satellite systems have been considered for their applicability to long-range ocean-crossing nonmilitary aircraft from 1965 to 1975. The navigations systems discussed are by no means the only competitors for position and course determination over transoceanic and high-altitude transcontinental regions; but the data and information should permit further comparison with other systems. It is concluded that magnetically slaved and free gyroscopes will continue to be the principal heading references for commercial aircraft. In their present form, inertial systems are competitive with Doppler navigation systems, at least in accuracy. The present configuration of Transit, the only satellite reference system scheduled for implementation, exhibits time gaps which would be serious for aircraft use. The single-fix accuracy appears adequate if additional satellites are orbited to provide more frequent fixes. Author

N63-14804 Michigan U. Inst. of Science and Tech., Ann Arbor
STUDY AND ANALYSIS OF SELECTED LONG-DISTANCE NAVIGATION TECHNIQUES, VOLUME II Final Report [Sept. 21, 1961-July 31, 1962]
James O'Day, Irvin Sattinger, Robert Scott, and Joseph Sullivan Mar. 1963 280 p 100 refs For abstract see N63-14803 11-22
(Contract ARDS-436)
(Rept. 4761-10-F(II))

N63-14820 Centro Di Studio Per La Fisica Delle Microonde, Florence (Italy)
ELECTROMAGNETIC CONTROL OF THE ATTITUDE OF SPACE VEHICLES Technical Report
P. Bruscaglioni and A. Consortini Dec. 1962 119 p 29 refs
(Contract AF 61(052)-536)
(AFCRL-63-83)

A theoretical investigation has been made of the possibility of applying the properties of elliptically polarized waves to the attitude control of space vehicles. Three different ways of applying electromagnetic radiation has been discussed. The first one employes an antenna on a space vehicle which radiates with circular polarization. The second one makes use of the torque experienced by a receiving antenna on the vehicle when a ground station radiates toward the vehicle. The third one is based on the simultaneous and tuned emission of radiation from an antenna located on the vehicle and from a ground antenna. A comparison between the torque which can be obtained and the torques necessary to the control of the attitude of a space vehicle in actual situations shows that the first procedure can have practical importance, while the torques obtained by means of the second and third procedures are too weak. Author

N63-15056 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
AIRCRAFT VORTEX WAKES IN RELATION TO TERMINAL OPERATIONS
Joseph W. Wetmore and John P. Reeder Washington, NASA, Apr. 1963 24 p 5 refs Presented at the Symp. on Development of Analytical Models for Estimating Airport Capacity, Calif. U., Nov. 29-30, 1962
(NASA TN D-1777) OTS: $0.75

An analysis has been made, on the basis of present understanding of trailing vortex characteristics, to provide an indication of the possible effects on aircraft encountering these vortices, the circumstances under which encounters might occur in terminal-area operations, and some means of dealing with the vortex problem in operations planning and traffic control. Author

23 PHYSICS, GENERAL

Includes: acoustics; cryogenics; optics; and thermodynamics.

For astrophysics see: 05 Astronomy and Astrophysics.

For related information see: 12 Geophysics; 29 Space Sciences; 24 Physics, Plasma; and 24 Physics, Solid-State.

N63-14750 Stanford Research Inst., Menlo Park, Calif.
ALMOST PERIODICITY AND THE QUANTAL *H* THEOREM
Ian C. Percival (University Coll., London) Repr. from J. Math. Phys., v. 2, no. 2, Mar.-Apr. 1961 p 235-239 10 refs
(NASA Contract NASw-80)

It is proved that the *H* theorem for an ensemble of isolated quantal systems with a discret energy spectrum is false, provided the systems satisfy certain broad conditions: the theorem is false for bounded many-particle systems with potential interaction, provided that interaction contains no repulsive singularities stronger than r^{-2} and no attractive singularities stronger than r^{-1}. Ensembles of such systems behave almost periodically, in the sense of H. Bohr. The entropy and the probability of finding an observable in a given range are both almost periodic functions of time. Author

N63-14751 Stanford Research Inst., Menlo Park, Calif.
EFFECT OF MUTUAL DISTORTION ON PHASE SHIFTS OF COLLIDING SYSTEMS
Ian C. Percival (University College, London) Repr. from Phys. Rev., v. 119, no. 1, July 1, 1960 p 159–164 9 refs
(NASA Contract NASw-80)

The box variational principle for scattering phase shifts is extended to one-channel collisions of arbitrary angular momentum without exchange, and also to systems with many degrees of freedom, when the energies are nonrelativistic and insufficient to produce inelastic collisions. Under reasonable assumptions of continuity, it is proved that the commonly used one-state and many-state approximations always reduce the scattering phase shift from its correct value, so long as no further approximations have to be made, and thus provide lower bounds to the exact scattering phase shift. The distorted wave approximation is an example. The inclusion of more states into a many-state approximation never makes the estimated phase any worse, and generally improves it. Mutual distortion of colliding systems never reduces the phase shift but generally increases it, thus producing an effective attraction between the systems. Author

N63-14771 Weizmann Inst. of Science, Rehovoth (Israel)
THEORY OF PRESSURE-INDUCED SHIFTS OF INFRARED LINES Annual Summary Report No. 2
A. Ben-Reuven (Ph. D. Thesis–Hebrew U.), H. Friedmann, and J. H. Jaffe Feb. 1963 42 p 33 refs
(Contract AF 61(052)-388)
(AFCRL-63-430)

A treatment is presented that accounts, to a large extent, for the j-dependence of pressure-induced shifts due to noble gases of lines in HCl bands. An improved phase-shift approximation for the intermolecular collision process is worked out with a coordinate system fixed in space during the collision. The main features of the observed phenomena are accounted for using only parameters calculated directly from known molecular properties. A discussion of the limitations of this theory is given. Author

N63-14777 Massachusetts Inst. of Tech. Lab. for Insulation Research, Cambridge
MAGNETIC LOSS PHENOMENA IN FERROMAGNETIC MATERIALS Final Report
D. J. Epstein et al July 1962 116 p 31 refs
(Contract AF 19(604)-5482)
(AFCRL-62-553)

Unusual magnetic properties (permeability relaxation, magnetic anneal, and a new type of hysteretic behavior) found in certain polycrystalline yttrium iron and lutetium iron garnets are studied. The room-temperature permeability spectrum was characterized by dispersion regions at microwave and at RF frequencies. The RF dispersion exhibits a temperature-activated shift to lower frequency with decreasing temperature. The activation energy for this process is very nearly equal to that for the a.c. resistivity. Magnetic annealing of these garnets produced uniaxial magnetic effects which can amount to about 20% of the first-order crystalline anisotropy constant. The hysteretic effects appeared at about −100° C where the 60-cps loop begins to develop some squareness. At liquid-nitrogen temperature, some samples show almost perfect square-loop behavior. However, if, at this temperature, the excitation frequency is reduced, a critical frequency is reached at which the loop reverts to normal behavior. These effects are explained by a model containing some Fe^{2+} ions which replace Fe^{3+} ions in octahedral sites. This model is verified by off-stoichiometric synthetic garnets which produce the same type of hysteretic effects. Two instruments resulting from these studies are described: one a vibrating sample magnetometer, the other an automatic torque magnetometer. Other areas covered include the electric and magnetic properties of vanadium oxide and the conductivity of titanium oxide at high temperature. R.C.M.

N63-14793 Union Carbide Nuclear Co., Oak Ridge, Tenn.
A PLUG-IN-TYPE MASS SPECTROMETER SURFACE IONIZATION SOURCE FOR USE WITH A VACUUM LOCK
W. W. Rice Apr. 15, 1963 16 p 6 refs
(Contract W-7405-eng-26)
(Y-1415) OTS: $0.50

A plug-in-type surface ionization source has been designed and built to be used with a mass spectrometer equipped with a vacuum lock. The sample filament mounts on a male plug which fits into a female receptacle mounted on a case plate. A firm electrical contact is realized. Sample plugs are changed without loss of vacuum and can be used with any geometrically orientated analyzer tube. Author

N63-14799 Comitato Nazionale per l'Energia Nucleare. Lab. Nazionali, Frascati (Italy)
MUON CAPTURE IN HYDROGEN
A. Fujii Dec. 20, 1962 12 p 14 refs
(*Its* Nota Interna 176; LNF-62/109)

The rate of muon capture by a proton is theoretically estimated within the framework of the universal V-A theory and this value is compared with the experimental capture rate in liquid hydrogen. Muon capture rate is calculated with the weak magnetic effects but without the pseudoscalar effect and then without the pseudoscalar and weak magnetic effects. D.E.R.

N63-14807 Aerochem Research Labs., Inc., Princeton, N.J.
ION AND ELECTRON PROFILES IN FLAMES
H. F. Calcote May 1962 25 p 36 refs Presented at the 9th Symp. (Intern.) on Combustion, Cornell U., Aug. 27–Sept. 1, 1962
(Aerochem-TP-45)

It is shown how Langmuir probes can be used in flames to obtain not only the positive ion concentration but electron concentrations and electron temperatures. An internal method is presented for checking the results by comparing the wall potential calculated from the above three quantities with the observed wall potential. Detailed results are presented for a number of flames. The positive ion concentration always exceeds the electron concentration, indicating the formation of negative ions. Electron temperatures exceed the gas temperature and do not decay as rapidly as might be expected. A mass spectrometric technique for obtaining ion profiles of good spatial resolution is outlined, and detailed profiles are presented for an acetylene-oxygen flame at 2.5 mm Hg. The ion CHO^+ peaks ahead of $C_3H_3^+$ which preceeds H_3O^+. Many other ions are observed to peak at about the same position in the flame as $C_3H_3^+$. Author

N63-14809 Rochester U., N. Y.
$\pi^{\pm}$-p ELASTIC SCATTERING AT 31.4 Mev
D. E. Knapp (Douglas Aircraft Corp.) and K. F. Kinsey Feb. 15, 1963 21 p 10 refs Submitted for Publication
(NYO-10257)

Five new measurements of $\pi^- + p$ and three of $\pi^+ + p$ elastic differential cross sections extend the angular range and the accuracy of the data near 30 Mev. These data, combined with the previous measurements at this energy, provide a significant improvement in the accuracy of s and nonresonant p wave phase shifts. A phase shift analysis yields four solutions, two of which are inconsistent with photoproduction measurements near threshold. One of the remaining two is preferred on the basis of a considerably more likely fit to recent charge exchange measurements at the same energy. Author

N63-14812 Oak Ridge National Lab., Tenn.
GAS-COOLED REACTOR PROGRAM Quarterly Progress Report for the Period Ending Dec. 31, 1961

W. D. Manly Apr. 6, 1962 286 p
(Contract W-7405-eng-26)
(ORNL-3254) OTS: $3.50

Progress in the program designed to develop a gas-cooled nuclear reactor included: investigations in the physics of a gas-cooled reactor system, structural studies, materials tests, design and construction of facilities, the Pebble-Bed reactor experiment, advanced reactor design and development, and fuel investigations. D.E.R.

N63-14819 Centro Di Studio Per La Fisica Delle Microonde, Florence (Italy)

ČERENKOV RADIATION FROM A CHARGED PARTICLE IN UNIFORM STRAIGHT MOTION THROUGH A PARTICULAR STRATIFIED MEDIUM Technical Note No. 2

L. Ronchi and A. M. Scheggi Nov. 1962 43 p 4 refs
(Contract AF EOAR 62-103)
(AFCRL-63-80)

A particular stratified medium is considered which is constituted of a number of thin, plane, parallel, and equispaced metallic films. The spacing between the films is filled with a perfect dielectric. A charged particle, in uniform straight motion goes through the structure, normally to the films. The velocity of the particle is above the Čerenkov threshold for the dielectric. The expression of the radiation is worked out as a function of different parameters. The radiation pattern is plotted in a number of particular cases. Author

N63-14829 Cambridge Acoustical Associates, Inc., Mass.

FREE AND FORCED VIBRATIONS OF A SPHERICAL SHELL

A. Silbiger Dec. 1960 19 p 6 refs
(Contract Nonr-2739(00))
(U-106-48)

The modes of vibration of a thin spherical shell have been studied to show that the frequencies for free extensional vibrations, as obtained by Lamb for symmetric mode shapes, are the only possible frequencies, e.g., the modes are degenerate. Starting with a set of Cartesian axes, a spherical coordinate system is set up. The nonaxisymmetric modes are obtained with this system by superposition of modes symmetric with respect to different axes. The extensional solution is shown to agree with the exact, three-dimensional solution in the limit of zero thickness. Equations are given for the response of the shell to an arbitrary harmonic load distribution. R.C.M.

N63-14842 National Bureau of Standards. Radio Standards Lab., Boulder, Colo.

PRACTICAL METHODS FOR CALIBRATION OF POTENTIOMETERS

David Ramaley Mar. 25, 1963 50 p 8 refs
(NBS-TN-172) GPO: $0.30

Potentiometer circuitry, particularly as related to calibration, is discussed with the primary consideration given to the required circuit measurements. The more feasible means of calibrating potentiometers are described in considerable detail. Emphasis is placed upon the use of the Universal Ratio Set as the basic implement for accomplishing the major portion of potentiometer calibrations. Author

N63-14843 Raytheon Co. Research Div., Waltham, Mass.

FAILURE MECHANISMS IN FERROELECTRIC AND NONLINEAR DIELECTRICS Technical Note No. 3

H. H. Barrett, P. B. Nutter, A. Paladino, and J. Van Hook Jan. 1963 32 p 11 refs
(Contract AF 30(602)-2678)
(S-510; RADC-TDR-63-99)

Pulse and d.c. breakdown measurements have been performed on single-crystal $SrTiO_3$ samples at room temperature. The necessary sample geometry to obtain bulk breakdown is described together with the technique of sample preparation. Breakdown fields in the vicinity of 4×10^7 v/m are observed. Attempts to measure the breakdown strength at liquid-nitrogen temperature show only that fields larger than 1×10^8 v/m are required. Oxidation rates for $SrTiO_3$ at 1500° C in air have been measured and indicate a time constant of about 2 minutes for a sample 5 mm thick. The observed oxidation rate is not affected by a 0.4 percent doping of Gd. The technique being used for more precise measurement of the oxygen diffusion rates is described. Author

N63-14846 National Bureau of Standards, Washington, D. C.

BASIC MAGNETIC QUANTITIES AND THE MEASUREMENT OF THE MAGNETIC PROPERTIES OF MATERIALS

Raymond L. Sanford and Irvin L. Cooter May 21, 1962 42 p 32 refs
(NBS-Monograph-47) GPO: $0.30

This paper gives general information regarding the two basic quantities, magnetic induction, B, and magnetizing force, H, and also the magnetic constant γm. Information is also given regarding the magnetic properties of various materials and methods and apparatus commonly used in the Magnetic Measurements Section for measuring these properties by means of reversed direct current or alternating currents of low frequency. In view of the gradual adoption of the rationalized mksa system of units, this system is included as well as the classical cgs electromagnetic system. Author

N63-14862 RAND Corp., Santa Monica, Calif.

THE QUANTUM ELECTRODYNAMICS OF A MEDIUM

H. T. Yura Mar. 1963 88 p 22 refs
(Contract AF 49(638)-700; Proj. RAND)
(R-410-PR)

By using the Feynman Diagram Technique, a unified analysis is made of the quantum electrodynamics of a medium. Both an atomic medium and an electron gas are considered. The photon propagator in a medium is calculated by summing the most highly divergent diagrams in each term of the perturbation-series expansion of the photon propagator. An explicit form for the interaction amplitude of two arbitrary currents in a medium is provided, from which a complete complex dielectric function is defined (at the pole of the photon propagator). Furthermore, the photon propagator is examined for its poles to obtain dispersion relations which yield the energy-momentum relation for free motion of the system. Explicit dispersion relations are found for both an atomic system and an electron gas over a wide range of energy and momentum variables. Damping (i.e., conductivity) and finite temperature effects are also discussed. The energy loss of fast incident charged particles passing through an atomic medium is obtained from the self-energy of the incident particle in the medium. The energy loss consists of three parts: loss due to excitation of atoms, loss due to ionization of atoms, and a Cerenkov loss. General features of the energy loss are discussed, and a number of expressions are given for the loss of various incident particles. Author

N63-14881 Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

PHASE-LOCKED LOOP DYNAMICS IN THE PRESENCE OF NOISE BY FOKKER-PLANCK TECHNIQUES

A. J. Viterbi Mar. 29, 1963 24 p 14 refs
(NASA Contract NAS7-100)
(JPL-TR-32-427) OTS: $2.60 ph, $0.92 mf

Statistical parameters of the phase-error behavior of a phase-locked loop tracking a constant frequency signal in the presence of additive, stationary, Gaussian noise are obtained by treating the problem as a continuous random walk with a sinusoidal restoring force. The Fokker-Planck, or diffusion, equation is obtained for a

general loop. An exact expression for the steady-state phase-error distribution is available only for the first-order loop, but approximate and asymptotic expressions are derived for the second-order loop. Results are obtained also for the expected time-to-loss of lock and for the frequency of skipping cycles. Threshold criteria for the phase-locked loop are discussed, and thresholds of approximate models which have been widely accepted are obtained by comparison with the exact results available for the first-order loop.
Author

N63-14894 Avco-Everett Research Lab., Everett, Mass.
ELECTRONIC TRANSITION MOMENTS FOR AIR MOLECULES
J. C. Keck, R. A. Allen, and R. L. Taylor Mar. 1963 34 p 46 refs
(Avco-Everett Res. Rept.-149)

Electronic transition moments for molecular bands which radiate strongly in air in the temperature range 4000° to 9000° K have been determined from available experimental data in conjunction with recently computed Frank-Condon factors. An analysis has also been made of the radiation in the infrared leading to effective Z^2 values for the free-free Kramers' radiation produced by electrons scattered from neutrals.
Author

N63-14924 Wisconsin U. Theoretical Chemistry Inst., Madison
COMPARISON OF THE HARTREE-FOCK ORBITAL WITH THE FIRST NATURAL SPIN ORBITAL FOR TWO-ELECTRON SYSTEMS
George V. Nazaroff and Joseph O. Hirschfelder Mar. 25, 1963 16 p 11 refs Submitted for Publication
(NASA Grant NsG-275-62(4180); Contract AF 33(657)-7311) (WIS-TCI-12) OTS: $1.60 ph, $0.80 mf

A demonstration is given that, for two-electron systems, the Hartree-Fock and first natural-spin orbitals are different functions. The method used is perturbation theory for which the zero-order problem is the Hartree-Fock approximation. A perturbation expansion through the second order is obtained for the first natural-spin orbital. The two orbitals begin to differ in the second order and their energies in the fourth order. An equation for the second-order part of the orbital difference function is derived. Estimates of the norms of the orbital difference functions are calculated for the ground states of the helium atom and the hydrogen molecule and are found to be small.
Author

N63-14951 Brookhaven National Lab., Upton, N. Y.
THE THERMAL NEUTRON SCATTERING LAW AND NEUTRON THERMALIZATION
P. Schofield Oct. 1962 35 p 14 refs
(Supported by AEC)
(BNL-770(T-288)) OTS: $0.75

The relation between the dynamics of the atoms of a moderating material and parameters considered important in the determination of thermal neutron spectra is discussed by considering a function which is the double Laplace transform of the symmetrized cross section $M(E)\sigma(E \rightarrow E')$ (where $M(E)$ is the Maxwellian distribution at the temperature of the moderator). In particular, the rate of energy exchange between a distribution of neutrons at one temperature and the moderator at another temperature is considered as giving a strong indication of the sensitivity of thermalization effects to details of the scattering law.
Author

N63-14952 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio
THE STRUCTURE FACTOR FOR A HARMONIC QUASI-TORSIONAL OSCILLATOR
M. I. Kay (Georgia Inst. of Tech.) and D. R. Behrendt Repr. from Acta Cryst. (Copenhagen), v. 16, pt. 3, Mar. 1963 p 157–162 5 refs

The scattering function for a harmonic librator has been calculated for small angles of oscillation. The results are compared with the usual form of the structure factor. To calculate the probability density function for an atom constrained to move on the surface of a sphere while oscillating as part of a rigid body, the harmonic potential function for an oscillator was derived as a function of angular displacements on the surface of the sphere.
Author

N63-14975 Maryland U., College Park
SINGLE-NUCLEON DAMPING OF COLLECTIVE VIBRATIONS
Richard A. Ferrell Nov. 1962 24 p Presented at the Eastern Theoretical Physics Conf., Virginia U., Charlottesville, Oct. 1962 (Partially supported by ONR)
(Tech. Rept. 279)

This paper reports on a Ph.D. thesis by M. Bauer of the University of Maryland. In this thesis, the shell model is used to calculate the damping in O^{16} over the diant dipole range of energy. These calculations differ from others by the inclusion of excitations into all possible s- and d-states. Equations are derived which distinguish between the resonance effect for γ-rays and the standard quantum mechanical resonance of a single nucleon in a potential well. The relationship of this work to that of other researchers is discussed.
R.C.M.

N63-14979 Space Technology Labs., Inc. Quantum Physics Labs., Redondo Beach, Calif.
A DYNAMICAL THEORY OF BARYONS
H. C. Corben Dec. 1962 35 p 5 refs
(Contract Nonr-3769(00))
(Rept. 8665-6002-RU-000)

The simplest relativistic wave equations for a particle, which in the classical limit possesses moments of inertia about more than one axis, are Dirac and Kemmer-Duffin equations containing extra terms which cause these equations to describe a variety of spin states. The classical field theory of such wave equations is developed and the generalized Dirac equation for particles of spin ½ and 3/2 is examined in detail.
Author

N63-15038 Syracuse U. Research Inst., N. Y.
MEASUREMENT OF DIFFRACTION FIELDS OF FINITE CONES BY A SCATTERING TECHNIQUE USING LIGHT MODULATION
Ayhan Vural Griffiss AFB, N. Y., Rome Air Development Center, Jan. 1963 100 p 23 refs
(Contract AF 30(602)-2646)
(EE 957-6301T3; RADC-TDR-63-15)

The present investigation perfects a new method for measuring microwave near-fields, and applies the techniques thus developed to the measurement of diffraction fields around finite cones. Extensive data on the diffraction field of finite cones have been obtained, verifying the advantages and usefulness of this method. Measurements have been largely confined to the principal component of the electric-field distributions but not limited to the principal planes. The cross-polarized component of the diffraction field was also measured. In all cases, it was insignificant in comparison with the principal component. The results of the principal plane measurements have also been plotted in three-dimensional contours which afford a better perspective.
Author

N63-15045 Air Force Cambridge Research Labs. Electronics Research Directorate, Bedford, Mass.
POSITIONING OF FERRIMAGNETS IN A RESONANT CAVITY TO INDUCE MAGNETOSTATIC MODES OF OSCILLATION
H. Roland Zapp (MIT) Jan. 1963 14 p 7 refs
(AFCRL-63-16)

Magnetostatic modes of oscillation arise when nonuniform magnetic fields are applied to a ferrimagnetic sample. This can be achieved by positioning a ferrimagnet within a microwave resonating cavity. The purpose of this paper is to find where in a cavity a sample must be placed to obtain particular modes of oscillation. Correct identification of magnetostatic modes is useful in computing one of the most important properties of magnetic substances—saturation magnetization. Two approaches are taken to the problem. The first yields a general equation for the location which will produce a desired mode. This equation tends to be mathematically complicated. The second approach places a sample in a symmetrical field position within the resonant cavity, checking to see which modes are present and their relative intensities. The latter method is mathematically simpler and permits practical application. Author

N63-15093 California U., Livermore. Lawrence Radiation Lab.
COUPLING EFFECTS OF HAFNIUM CONTROL RODS IN A NEAR-HOMOGENEOUS, BeO-MODERATED, ORALLY-FUELED SYSTEM
J. M. Piowaty, John R. Morton, III, and Loren L. Gardner Feb. 27, 1963 13 p 4 refs
(Contract W-7405-ENG-48)
(UCRL-7262) OTS: $0.50

Two series of measurements were made to examine the coupling effects of hafnium control rods. From two to five rods were used. The measurements were performed on a BeO-moderated, U^{238}-fueled system with a BeO/U^{235} molar ratio of 247. The pulsed neutron technique was used. Author

N63-15139 Harvard U., Cambridge, Mass.
MEASUREMENTS OF SECONDARY SPECTRA FROM HIGH-ENERGY NUCLEAR REACTIONS
Karl Strauch *In* Atomic Energy Commission. Div. of Tech. Inform., Wash., D. C. Protection Against Radiation Hazards in Space Proc. of the Symp. at Gatlinburg, Tenn., Nov. 5–7, 1962 p 409–432 31 refs (See N63-15138 11-28) OTS: $7.00
(Paper D-2)

The mechanism of the interaction of a high-energy nucleon with a complex nucleus is discussed, and the various types of reaction are described. The available experimental data on secondary particles are summarized, emphasis being placed on those secondaries that might be important for shielding considerations. Author

N63-15140 Oak Ridge National Lab., Tenn.
MONTE CARLO CALCULATIONS FOR INTRANUCLEAR CASCADES
H. W. Bertini *In* Atomic Energy Commission. Div. of Tech. Inform., Wash., D. C. Protection Against Radiation Hazards in Space Proc. of the Symp. at Gatlinburg, Tenn., Nov. 5–7, 1962 p 433–522 18 refs (See N63-15138 11-28) OTS: $7.00
(Paper D-3)

Calculations have been made for nucleons and pions incident on complex nuclei at energies where pion production is not likely (≈ 350 Mev). The interaction with the nucleus as a whole is represented by individual particle-particle collisions within the nucleus where the history of each particle involved in the collision is traced. Extensive comparisons with experiment are made to examine the limits of validity of the model. The effect of a diffuse nuclear edge is examined for certain reactions. It is demonstrated that the model can be used to predict a broad range of experimental results for incident nucleons, whereas the predictions for incident pions are not as reliable as those for nucleons when detailed information is required. It is shown that the bulk of the effects which result when a diffuse nuclear edge is used comes from the increased nuclear dimensions rather than from the edge itself. A compilation of the results for incident nucleons and pions is being prepared, and some preliminary results are presented. Author

N63-15185 Argonne National Lab., Ill.
PHYSICS DIVISION SUMMARY REPORT, JANUARY-FEBRUARY 1963
Lowell M. Bollinger [1963] 95 p 9 refs
(Contract W-31-109-eng-38)
(ANL-6679)

A summary is given for the following projects: tandem Van de Graaff accelerator, pulsed-beams, excited states of light nuclei, deuteron-induced reactions, elastic scattering of protons, capture gamma-ray spectra for neutrons, mu-mesonic X-rays from atoms, ionization by ions in the mev range, fragmentation of hydrocarbons, deformation energy of a charged liquid drop, resonance theory of nuclear reactions without boundary conditions, superconductivity, particles with zero or near-zero mass, and foundations of quantum mechanics. R.C.M.

N63-15212 Los Alamos Scientific Lab., N. Mex.
LASL LENS DESIGN PROGRAM FOR THE IBM 7090
C. A. Lehman Apr. 4, 1963 113 p 3 refs
(Contract W-7405-eng-36)
(LA-2837) OTS: $2.50

A program for the design of optical-lens systems by the method of least squares has been written for use on the IBM-7090 Electronic Data Processing System. This program has been found to work very well in improving existing lens designs. The body of this report consists of a theoretical development of the equations used by the program. The appendixes contain information for those desiring to use the program. Author

N63-15219 Los Alamos Scientific Lab., N. Mex.
APPROXIMATE MODELS FOR THERMALIZATION IN SOLIDS
K. D. Lathrop Apr. 8, 1963 55 p 16 refs
(Contract W-7405-eng-36)
(LA-2834) OTS: $1.25

To describe neutron thermalization in solids, it is postulated that chemical binding effects can be represented by an atom-speed distribution and a free-particle neutron-atom interaction. Three atom-speed distributions prepared from elementary atomic models are used with the Wigner-Wilkins formalism to prepare the scattering terms of the neutron-thermalization balance equation for an infinite medium. The resulting equations are solved numerically. Where possible, numerical solutions are compared with analytic solutions. Asymptotic solutions for large neutron energy are found to agree with those derived by Corngold. Numerical solutions for equations describing thermalization by single-energy-hydrogen classical harmonic oscillators agree well with experimental results for thermalization in zirconium hydride, but the choice of parameters used to obtain agreement is somewhat arbitrary. Author

N63-15224 Aerospace Medical Div. School of Aerospace Medicine, Brooks AFB, Tex.
PRELIMINARY DOSE MEASUREMENTS ON THE NEUTRON GENERATOR
Paul J. Ebert and Ronald W. Benson Mar. 1963 10 p 9 refs
(SAM-TDR-63-18)

Neutron fluxes are produced by the neutron generator at the USAF School of Aerospace Medicine, using the d(d,n)He^3 and T(d,n)He^4 reactions. An experimental procedure for determining the flux produced by the d(d,n)He^3 reaction is presented. Author

N63-15238 National Aeronautics and Space Administration, Washington, D.C.
APPLICATION OF THE METHOD OF PARTIAL SEPARATION OF VARIABLES TO TWO EQUIVALENT *p*-ELECTRONS (PRIMENENIYE METODA NEPOLNOGO RAZDELENIYA PEREMENNYKH K DVUM EKVIVALENTNYM *p*-ELEKTRONAM)

A. P. Yutsis Apr. 1963 32 p 4 refs Transl. by Faraday Translations from Zh. Eksperim. i Teor. Fiz. (Moscow), v. 23, no. 4(10), 1952 p 357-370
(NASA TT F-152) OTS $1.00

A discussion is presented of the radial integrals that express the total energy of the atom, in the case of partial separation of the variables after integration with respect to the spin and angular variables. Means of evaluating the kinetic energy integrals and integrals of electrostatic energy of the exchange type are described. Results of calculations for He, Li^+, and Be^{++} in the $2p^2$ configuration, obtained by the method of partial separation of variables, are presented in tabular form. Author

24 PHYSICS, PLASMA

Includes: fusion; and magnetohydrodynamics.

For related information see: 05 Astronomy and Astrophysics; 23 Physics, General; and 25 Physics, Solid-State.

N63-14752 Sandia Corp., Albuquerque, N. Mex.
SPECTROGRAPHIC ANALYSIS OF PLASMAJETS Progress Report II
K. L. Shipley Mar. 1963 33 p 11 refs
(SC-4776(RR.) OTS: $0.75

This is the second progress report on the work performed at Sandia Corporation in the use of spectrographic techniques in plasmajet diagnostics. Typical results of spectrographic data from argon and nitrogen plasmajets are included. For the argon jet, the results from line intensity measurements of ionized and un-ionized atoms generally give good information. However, results from hydrogen line broadening measurements indicate several unexplained discrepancies. For the nitrogen jet, the N_2^+ (0, 0) and N_2^+ (0, 1) bands from the first negative series were used to determine a rotational temperature. Author

N63-14774 Polytechnic Inst. of Brooklyn. Microwave Research Inst., N.Y.
MAGNETOHYDRODYNAMIC STABILITY OF A TOROIDAL PLASMA STRUCTURE Research Report
Jeffrey Freidberg May 10, 1962 48 p 8 refs
(Contract AF 30(602)-2149)
(PIBMRI-1025-62; RADC-TDR-62-284)

The purpose of this report is to macroscopically treat the problem of stability in a specific plasma configuration. There are numerous possibilities for different types of stabilities and instabilities which can arise in the given configuration. However, only one mode of plasma motion is considered in this report. The results of the investigation indicate that, for this mode, the plasma is stable under a great variety of perturbations. Under certain conditions, however, the plasma is found to be unstable. The nature of the instability is such that the plasma drifts through the confining magnetic field. Author

N63-14775 Garrett Corp. AiResearch Mfg. Div., Los Angeles, Calif.
VORTEX MAGNETOHYDRODYNAMIC GENERATOR EXPERIMENTAL TEST PROGRAM [Final Report, Aug. 1, 1961 to Apr. 6, 1962]
H. G. Starck et al Wright-Patterson AFB, Ohio, Flight Accessories Lab., June 1962 73 p
(Contract AF 33(616)-7808)
(ASD-TDR 62-459)

A vortex-type magnetohydrodynamic generator was designed and fabricated on the basis of currently available materials, and was tested to determine the feasibility of obtaining electric power from a seeded combustion gas. The combustion gas was oxygen-hydrogen, seeded with potassium hydroxide solution. A power output of 0.15 watts was obtained from a vortex channel which was 4 inches wide with a magnetic field strength of 4000 gauss. The gas flow rate varied from 0.4 to 0.7 pounds per minute. This result compares with a theoretical output of 29 to 60 watts which was calculated by digital computer methods. The low output was due to material failures throughout the unit and particularly of the combustion chamber and the center electrode. The study program indicated that the small vortex MHD generator has a significant potential provided that the material problems can be solved: either through the use of lower ionization temperature fluids or higher temperature materials. Author

N63-14805 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio
EXPERIMENTAL EVALUATION OF A DIRECT-CURRENT LOW-PRESSURE PLASMA SOURCE
Stanley Domitz Washington, NASA, Apr. 1963 34 p 16 refs
(NASA TN D-1659) OTS: $1.00

A plasma source, which consists of a hot-filament coaxial discharge in an axial magnetic field, was operated with argon gas. The quantities measured in the plasma beam were the magnitude plus spatial distribution of electron temperature, number density, and plasma potential. The plasma production efficiency is given as a function of the discharge parameters. The plasma beam was found to be up to 10 percent ionized with a minimum energy cost of 125 electron volts per ion, excluding filament and magnet power. Author

N63-14847 Air Force Systems Command. Foreign Technology Div., Wright-Patterson AFB, Ohio
ELECTRIC-ARC PREHEATERS FOR FORMATION OF HIGH-TEMPERATURE JETS
A. G. Shashkov, O. I. Yas'ko, V. L. Sergeyev, and F. B. Yurevich Sept. 18, 1962 28 p 51 refs Transl. from Inzhenerno-Fiz. Zhur. (Minsk), v. 5, no. 1, Jan. 1962 p 115-129
(FTD-TT-62-1092/1+2; AD-286-591)

Methods of raising arc temperature, specifications for electric arc preheaters, and factors limiting elevation of the jet parameters were surveyed. It was found that: electric arc preheaters provide the most effective way to obtain high axial temperatures (15,000° to 17,000° K) in a jet for considerable periods of time. Current specifications for electric arc preheaters call for an increase in the parameters of the jet, prolonged operating time, and reduced contamination of the plasma. A.R.S.

N63-14864 National Bureau of Standards. Central Radio Propagation Lab., Boulder, Colo.
ON PLASMA COLLISION FREQUENCIES PROPORTIONAL TO ENERGY IN THE RADIO WAVE REFLECTION AND TRANSMISSION PROCESS
J. R. Johler and John D. Harper, Jr. Mar. 1, 1963 73 p 45 refs
(Contract AF 30(602)-2488)
(NBS-TN-164) GPO: $0.40

An extensive survey of both the index of refraction of typical electron-ion plasmas as models of the ionosphere, together with the reflection coefficients is made to determine the significance of the notion of heavy-particle electron-collision frequencies proportional to energy. The introduction of electron-ion collision frequencies with a linear dependence upon the average value of the Maxwellian particle-velocity distribution results in some interesting changes in the detail of the reflection and transmission coefficients at low frequencies. The reflection coefficients determined by application of the continuously stratified notion to particular models of the ionosphere are not drastically changed by the introduction of such electron collisions. Author

N63-14873 National Aeronautics and Space Administration. Langley Research Center, Langley Air Force Base, Va.

A THEORETICAL STUDY OF THE MOTION OF AN IDEALIZED PLASMA RING UNDER THE INFLUENCE OF VARIOUS COAXIAL MAGNETIC FIELDS

Clarence W. Matthew Washington, NASA, 1961 19 p 6 refs (NASA TR R-121) GPO: $0.30

The equations of motion of charged particles in a magnetic field have been applied to the problem of the motion of an idealized plasma ring in the magnetic fields arising from direct and/or alternating current flowing through a set of coaxial drive coils. The simplifications involved are such that the theory predicts the maximum velocities obtainable with the induced-electromotive-force plasma accelerator, the maximum axial velocities attained can be expressed by two simple empirical equations, one for small velocities and the other for large velocities, provided the constants are originally determined by applicable data. The results of a preliminary survey of multicoil traveling-wave accelerators indicate that such accelerators have very exacting design requirements if the plasma ring is to be contained within the accelerator throughout the entire process. Author

N63-14997 Princeton U. Plasma Physics Lab., N.Y.

SOME COMPUTER EXPERIMENTS WITH A ONE-DIMENSIONAL PLASMA MODEL

Craig Smith and John Dawson Jan. 1963 177 p 28 refs
(Contract AT(30-1)-1238)
(MATT-151)

Two computer experiments on the instability which results from the passage of a current through a plasma are reported. The exact one-dimensional trajectories of a system of charge sheets are numerically followed by the computer, to find what levels the amplitude of the unstable modes will grow before being limited by nonlinear effects, and what quasi-equilibrium state the plasma will seek so as to prevent further growth. The low-current experimental results agree generally with the recent "quasi-linear" theories, but the high-current model results show a great deal of plasma instability which was not resolvable by the criteria of the linear theory. D.E.R.

N63-14998 Princeton U. Plasma Physics Lab., N.J.

THE VARIATION OF NEUTRAL DENSITY WITH TIME IN C-STELLARATOR DISCHARGES

D. J. Grove (Westinghouse Research Labs.) and W. Stodiek Dec. 1962 15 p 1 ref
(Contract AT(30-1)-1238)
(MATT-161)

The original population of neutral hydrogen molecules is reduced by dissociation and ionization during the ionization phase of a typical stellarator discharge. Programed ohmic heating pulses are used in this experiment to complete the ionization in a few hundred microseconds after which the plasma is held at about 1 ev for 20 milliseconds or more. During this holding period, the electron density falls to a very low value. At varying times during the 1 ev period, a probe pulse of ohmic heating current is programed to ionize the neutral gas present, and the resulting increase in plasma density is taken as a measure of the neutral density. Results indicate that: (1) There is a time-dependent source of neutral gas which is a result of a return from the walls of the incident ions and neutral atoms. (2) The percentage return is small for several milliseconds. (3) Those particles incident as neutral atoms appear to stick to the walls for 5 to 8 milliseconds. I.v.L.

N63-14999 Princeton U. Plasma Physics Lab., N.J.

TWO-PARTICLE CORRELATION FUNCTION FOR AN UNSTABLE PLASMA

R. H. Rutherford and E. A. Frieman Nov. 28, 1962 22 p 11 refs
(Contract AT(30-1)-1238)
(MATT-175)

The usual kinetic equation derived from the B-B-G-K-Y hierarchy for a plasma with Coulomb interparticle forces breaks down for plasmas with distribution functions which the linearized Vlasov equation would predict to be unstable. As the first step towards deriving a kinetic equation for an unstable plasma, the equation for the two-particle correlation function is solved for times for which the distribution function may be regarded as time independent. Part of the correlation function is shown to grow exponentially in time; thus the Bogoliubov adiabatic hypothesis breaks down. Taking only the fastest growing part of the correlation function, a velocity space-diffusion equation is obtained for the distribution function with a time-dependent diffusion coefficient. Author

N63-15025 Princeton U. Plasma Physics Lab., N.J.

ON THE STABILITY OF HYDROMAGNETIC SYSTEMS WITH DISSIPATION

Bruno Coppi Jan. 1963 40 p 12 refs
(Contract AT(30-1)-1238)
(MATT-143)

In the present work, the effects of electrical resistivity, viscosity, and thermal conductivity on the stability of a hydromagnetic system are examined. A motion equation governing small displacements about the equilibrium, and the associated quadratic form which replaces the energy principle are derived. Proper expressions for these equations are deduced by using different expansion techniques in order to obtain information about the influence of the various dissipative parameters on modes which are stable, marginally stable, or singular in their absence. The fastest growth rates are evaluated, and the main features of the possible instabilities are deduced in general. Author

N63-15026 General Electric Co. Space Sciences Lab., Philadelphia, Pa.

MICROWAVE REFLECTION BY NON-UNIFORM PLASMA WITH EXPONENTIAL ELECTRON DISTRIBUTION

K. T. Yen May 1962 26 p 4 refs
(Contract AF 30(602)-1968)
(R62SD47-Class 1; previously issued as RADC-TDR-62-433)

Microwave reflection by nonuniform plasmas, with an exponential electron distribution which approaches an equilibrium value far downstream, is considered. Several approximate formulas for the reflection coefficient and phase-shift angle are presented. Some numerical calculations have been carried out, and the results are presented in graphs. Comparison of the present results with those for "ramped" electron distributions shows an interesting point; i.e., when piecewise linear segments are used to represent a continuous electron distribution, the wave interactions thus produced may have significant effects for the reflection and transmission of electromagnetic waves. Author

N63-15028 Princeton U. Plasma Physics Lab., N.J.

ON EQUILIBRIUM OF A CURRENT CARRYING TOROIDAL PLASMA. II. EXPERIMENTS WITH THE MODEL C-STELLARATOR

Rolf M. Sinclair, S. Yoshikawa, W. L. Harries, and John O. Kessler (RCA) Jan. 1963 40 p 27 refs Presented at the 4th Annual Meeting of the Div. of Plasma Phys., Am. Phys. Soc., Atlantic City, Nov. 28–Dec. 1, 1962 Submitted for Publication
(Contract AT(30-1)-1238)
(MATT-165)

A series of experiments with the Model C stellarator showed that a previously detected asymmetry in the device could be removed by applying such a magnetic field B_v transverse to the main confining magnetic field, that an inherent lack of closure of the flux lines of the confining field was removed. The symmetrized stellarator was then used to demonstrate that an equilibrium (discussed theoretically elsewhere) could be achieved in the plasma by applying a uniform magnetic field transverse to the plane of the

stellarator. With current I_{OH} flowing toroidally in the plasma, the tendency for the toroid to expand, due to the hoop force and the U-bend drift, is counterbalanced by the $I_{OH} \times B_T$ force. The observed transverse field required for equilibrium is in good agreement with the value predicted theoretically. Improvement at equilibrium of such plasma parameters as electron temperature, particle confinement time, and energy replacement time is demonstrated. Author

N63-15069 Ling-Temco-Vought, Inc. Research Center, Dallas, Tex.

THE THERMODYNAMIC PROPERTIES OF HIGH TEMPERATURE NITROGEN

K. G. Sewell July 1962 62 p 13 refs
(Rept. 0-71000/2R-25)

The thermodynamic properties of nitrogen were calculated for a range of temperatures from 2000° K to 100,000° K and for a range of density ratios based on standard atmospheric density from 10^{-10} to 10^{2}. The data are presented in charts which include enthalpy, pressure, entropy, specific heats, speed of sound, compressibility factor, and species concentrations. Author

N63-15095 Armour Research Foundation, Chicago, Ill.

NANOSECOND PULSE BREAKDOWN STUDY Final Report [May 15-Nov. 15, 1962]

Lawrence C. Scholz Dec. 1962 65 p 48 refs
(Contract AF 30(602)-2780)
(ARF-A217-7; RADC-TDR-62-616)

A summary of microwave gas-breakdown theory is presented with special emphasis on nanosecond pulse breakdown. The various approaches previously presented in the literature are compared and shown to be identical as far as practical results. It is suggested that, in general, for pressure-time products greater than 1 torr-nanosecond, measurements made under cw conditions will be satisfactory. Author

N63-15105 Polytechnic Inst. of Brooklyn. Microwave Research Inst., N.Y.

MICROWAVE PROBING OF ELECTRON DECAY IN A GAS DISCHARGE

Marland C. Gale Jan. 18, 1963 21 p 4 refs
(Contract AF 19(604)-7216)
(PIBMRI 977-61; AFCRL-63-17)

A method is described for determining the electron density and collision frequency in the afterglow of a pulsed discharge in hydrogen. The results indicate that the electron density does not decay exponentially, but that it decays more rapidly at first and less rapidly later. It is shown that this is probably due to the existence of a net negative charge in the center of the discharge tube, arising from sputtering of the cathode metal onto the walls of the tube, or to the presence of impurity atoms. Author

N63-15194 General Electric Co. Space Sciences Lab., Philadelphia, Pa.

TECHNIQUES FOR EXPERIMENTAL INVESTIGATION OF THE PROPERTIES OF ELECTRICALLY CONDUCTING HYPERSONIC FLOW FIELDS

E. P. Muntz, C. J. Harris, and E. M. Kaegi Mar. 1963 90 p 41 refs
(Contract AF 04(647)-269)
(R63SD27)

Current studies involving characteristics of the plasmas generated by high-speed flight, including experimental techniques used to overcome difficulties involved in the characterization of high-enthalpy flows, are discussed. The first section of this report describes three techniques being used to measure the properties of the free stream in a hypersonic nonequilibrium flow. The second section contains a description of two possible methods for examining the electrical properties of shock-tunnel-generated plasma flows in detail. Author

25 PHYSICS, SOLID-STATE

Includes: semiconductor theory; and masers.

For related information see: 09 Electronics; 23 Physics, General; and 24 Physics, Plasma.

N63-14768 Aeronautical Systems Div. Physics Lab., Wright-Patterson AFB, Ohio

ANNOTATED BIBLIOGRAPHY ON SOLID STATE OPTICAL AND INFRARED MASER MATERIALS (A Summary of Abstracts from Current Literature up to Dec. 1961)

Dieter Feldmann Jan. 1963 38 p 107 refs
(ASD-TDR-62-1026)

This report contains abstracts of approximately 110 articles from 25 different scientific journals. It covers theory and survey; solid state maser materials; maser optics; properties (coherence and others); related basic research; and organic, semiconducting, and gas masers. The survey includes articles from the beginning of the optical maser research to December 1961. Author

N63-14831 Armour Research Foundation, Chicago, Ill.

INVESTIGATION OF NARROW LINE PARAMAGNETIC RESONANCE ABSORPTION SPECTRUM IN SINGLE CRYSTAL CALCITE Final Report, Apr. 5-Nov. 5, 1962

Samson A. Marshall and S. Nudelman 1963 26 p 23 refs
(Contract AF 30(602)-2755)
(ARF-A1216-7)

The results of a program of study are presented on the Investigation of a Narrow Five Line Spectrum in Irradiated Calcite Single Crystals. The objective of the program was to discover, by a systematic investigation of the properties of the electron-paramagnetic-resonance absorption-spectrum of these five narrow lines, the defect center or centers responsible for the spectrum. A secondary objective of the study was to make recommendations regarding the usefulness of this spectrum for a quantum-electronic device. To date, it is concluded that this five-line spectrum is generated by more than one defect center. The conclusion was reached by comparing the irradiated and unirradiated spectra. The spectrum of what is tentatively called a "butterscotch" defect center was also discovered. This defect center appears to be a CO_2^- ion located at a carbonate ion site in calcite. Author

N63-14868 RAND Corp., Santa Monica, Calif.

THE INTERACTION OF LASER LIGHT WITH METALS (ELECTRON-OPTICAL PHONON INTERACTION IN METALS)

H. T. Yura Mar. 1963 38 p 7 refs
(Contract AF 49(638)-700; Proj. RAND)
(RM-3560-PR)

The interaction of laser light with a metal is studied. A model is proposed in which the dominant mechanism for electron de-excitation in transition metals is by the emission of optical phonons, as contrasted to the simple metals where the dominant mechanism is by the emission of acoustic phonons. Calculations based on this model give, for steel, an electron—optical phonon relaxation time $\sim 10^{-7}$ to 10^{-6} sec, compared with an electron—acoustic phonon relaxation time $\sim 10^{-11}$ to 10^{-10} sec, for a simple metal such as copper. Author

N63-14869 Radio Corp. of America. RCA Labs., Princeton, N.J.
INVESTIGATION OF CARRIER INJECTION ELECTROLUMINESCENCE Semiannual Scientific Report No. 3, July 15, 1962 to Jan. 15, 1963
A. G. Fischer, W. H. Fonger, and A. S. Mason David Sarnoff Research Center, Feb. 15, 1963 36 p 10 refs
(Contract AF 19(604)-8018)
(AFCRL-63-62)

The following advances in the growth of crystals of II-VI compounds (ZnSe and ZnTe) and in preparing electroluminescent junctions are related. A magnetic Czochralski puller for temperatures where magnets normally lose their susceptibility has been constructed. Experiences with the epitaxial growth of ZnSe and ZnTe are described. N-type ZnSe crystals exhibit light absorption due to free carriers. Electroluminescent emission at nonohmic contacts is due to impact-ionization excitation. The new concept of tunnel-injection electroluminescence has been reduced to practice; light emission from CdS layers has been obtained. A new effect, electrical modulation of photoluminescence in CdS, has been discovered. The compounds AlP and BP are apparently not miscible. The value for the lattice constant of AlP has been corrected. Injection electroluminescence was observed in boron phosphide crystals. The methods for evaporation of ZnSe films on hot substrates were improved, and the light scattering and luminescent properties of such films were studied. Author

N63-14994 Lincoln Lab., Mass. Inst. of Tech., Lexington
CYCLOTRON RESONANCE AND MAGNETO-OPTICAL EFFECTS IN SEMI-CONDUCTORS
B. Lax and J. Halpern Apr. 30, 1962 93 p 22 refs
(Contract AF 19(604)-7400)
(Tech. Rept. 249)

The band structure of semiconductors has been studied by a variety of techniques. Two very important techniques have included cyclotron resonance and magneto-optical phenomena. Cyclotron resonance has been discussed theoretically, both from a classical and a quantum-mechanical viewpoint. On the experimental side, the results of microwave, millimeter and infrared measurements, together with the theoretical interpretation, are presented. The magneto-optical phenomena are divided into three major categories: intraband, interband, and Zeeman effect. The intraband effects are treated by the Drude-Zener theory in a magnetic field and include plasma and magnetoplasma effects, and free-carrier Faraday rotation and Voigt effect. The interband phenomena cover such topics as magnetoabsorption, magnetoreflection, the interband Faraday rotation, and the Voigt effect. The theory is a semiclassical dispersion theory in which the quantum-mechanical features are inserted to account for the phenomena properly. Finally, the Zeeman effect treats the experiments of impurities in germanium and silicon and those of the excitons in germanium. Author

N63-15043 National Carbon Co., Parma, Ohio
RESEARCH AND DEVELOPMENT ON ADVANCED GRAPHITE MATERIALS. VOLUME II—APPLICATIONS OF ANISOTROPIC ELASTIC CONTINUUM THEORY TO DISLOCATIONS IN GRAPHITE
G. B. Spence Wright-Patterson AFB, Ohio, Directorate of Materials and Processes, Feb. 1962 54 p 27 refs For Vol. III see N62-18898 17-18; for Vol. VI see N63-15044 11-19; for Vol. VIII see N63-10630 02-09; for Vol. XI see N63-10714 02-19
(Contract AF 33(616)-6915)
(WADD-TR-61-72, Vol. II)

Eshelby, Read, and Shockley's theory of dislocations in an anistropic elastic continuum has been used to derive formulas not involving complex numbers for the stress components of straight dislocations in certain symmetry directions. From these, the dependence of stacking fault energy γ_F on the orientation of the Burgers vector and on the width of extended dislocations and triple partial ribbons, and the dependence of γ_F on the radius of curvature of extended nodes have been calculated. The theory is applied to to graphite and close-packed metals. All three methods of determining γ_F for graphite yield results which are compatible with the value 0.6 ± 0.2 erg/cm^2. The rough estimate of error is based on uncertainties in the elastic constants and differences in experimental results. The dependence of width on depth from the stress-free surface has been calculated for an arbitrarily oriented dislocation lying parallel to the surface of a semi-infinite isotropic body and a 30° extended dislocation and a symmetrical, screw triple partial ribbon in certain symmetry directions in an anisotropic plate. A procedure for correcting the widths observed in electron microscopy of thin films is given. Author

N63-15067 Air Force Cambridge Research Labs. Electronics Research Directorate, Bedford, Mass.
LASERS—A BASIC DISCUSSION OF TYPES, PROPERTIES, AND PRINCIPLES Research Note
C. Martin Stickley Jan. 1963 29 p 6 refs
(AFCRL-63-1)

This report describes the basic aspects of a laser. It includes a quantitative discussion of the major properties and the different types of lasers, as well as the basic laser mechanism—stimulated emission. Several applications are presented in order to illustrate the properties of the laser. Author

N63-15070 Cornell U. Lab. of Atomic and Solid State Physics, Ithaca, N.Y.
TUNNELING BETWEEN SUPERCONDUCTORS
Alexis Baratoff and Vinay Ambegaokar [1963] 13 p 10 refs
(Contract Nonr-401(38))

The effects of tunneling between superconductors separated by an oxide layer are analyzed by the method of thermodynamic Green's functions. These effects (an oscillating supercurrent of frequency 2ev/h and a possible d.c. supercurrent at zero voltage) were recently predicted by Josephson, whose derivation was objected to by Bardeen on the grounds that the position-dependent energy gap goes rapidly to zero in the barrier. The assumption is made that Josephson's effects occur because the amplitudes for condensed pair formation and disruption (Gor'kov's F functions) may overlap in the oxide layer even though the gap is essentially zero there. The derivation presented here answers Bardeen's objections and shows that a simple prediction for the temperature dependence of the d.c. supercurrent follows from the theory. R.C.M.

N63-15104 Radio Corp. of America. RCA Labs., Princeton, N.J.
INVESTIGATIONS OF FUNDAMENTAL LIMITATIONS DETERMINING THE ULTIMATE SIZE OF MICROSTRUCTURES Special Scientific Report No. 2
J. T. Wallmark David Sarnoff Research Center, Dec. 31, 1962 21 p 9 refs
(Contract AF 19(604)-8040)
(AFCRL-63-12)

It has been shown that a minimum size and a maximum packing density exists for semiconductor devices, based on various physical phenomena. This report similarly treats solid-state devices in general, i.e., active devices (such as magnetic, superconductive, and dielectric devices) as well as passive devices (such as resistors, capacitors and inductors). It is shown that solid-state devices are limited to a minimim size of about 3 microns on a side. In a circuit, the minimum space per component is about 6 microns on a side corresponding to a maximum packing density of about 5×10^9 components/cm^3 (7×10^{10} components/in^3). The chief limiting physical phenomenon is the edge definition in fabrication of devices. For superconductive devices, the cooling equipment is a major limiting factor to high packing density. Author

N63-15111 Industrial Science and Technology Agency. Electrotechnical Lab., Tokyo (Japan)
THE MEASUREMENT OF 10 Gc/s MICROWAVE POWER, EMPLOYING THE HALL EFFECT IN SEMICONDUCTORS
Shoei Kataoka (M.S. Thesis–University Coll., London) June 1962 70 p 32 refs Submitted for Publication
(*Its* Researches 626)

This report describes experiments on the measurement of microwave power at 10 gc/s employing the Hall effect produced in single crystals of *n*- and *p*-type germanium when errected on the axis of a hollow metal, rectangular waveguide carrying the power. So far as is known, this is the first recorded observation of the Hall effect at this frequency, and it has been shown possible to apply the effect with the help of a suitable phase-adjustment device to the design of a wattmeter. For that purpose, the Hall output from a crystal was calibrated against the power measured independently, and the relationship was found to be practically linear. From these power measurements and consideration of the conditions of operation of the crystal, the Hall coefficients for the *n*- and *p*-types of germanium used were deduced and shown to be of the same order of magnitude as the d.c. values. An investigation of the impedance of the crystal circuit led to the conclusion that the contribution to the Hall effect from the displacement current in the crystal was very small compared with that of the conduction current. The success of this application depends largely upon the development of suitable crystal units and, toward that end, new techniques were introduced. Author

N63-15124 Bell Telephone Labs., Inc., Murray Hill, N.J.
SURFACE EFFECTS OF RADIATION ON TRANSISTORS
D. S. Peck, R. R. Blair, W. L. Brown, and F. M. Smith *In* Atomic Energy Commission. Div. of Tech. Inform., Wash., D.C. Protection Against Radiation Hazards in Space Proc. of the Symp. at Gatlinburg, Tenn., Nov. 5–7, 1962 p 136–200 8 refs (See N63-15114 11-28) OTS: $7.00
(Supported by the Air Force)
(Paper B-2)

The effects of radiation on the surface properties of semiconductors have been studied. Included are: the classes of radiation effects on bulk properties, observations of effects on surface properties, model of the radiation process, experimental results of testing the radiation mechanism, characterization of effects, and testing and selecting devices for use in Van Allen belts. The principal surface effect is seen to be the induction of surface inversion layers that alter the junction characteristics which are caused by the activation of chemical species by gas ions. D.E.R.

N63-15126 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
THE EFFECTS OF PROTONS ON SEMICONDUCTOR DEVICES
William C. Honaker *In* Atomic Energy Commission. Div. of Tech. Inform., Wash., D.C. Protection Against Radiation Hazards in Space Proc. of the Symp. at Gatlinburg, Tenn., Nov. 5–7, 1962 p 220–229 8 refs (See N63-15114 11-28) OTS: $7.00
(Paper B-4)

Experimental results are presented covering the data obtained from the bombardment of several transistors with 40 and 440 Mev protons. The data indicated a proton energy as well as a transistor frequency dependence on degradation. Figures are presented showing relative degradation of transistors with integrated flux. Author

N63-15127 Radio Corp. of America, New York, N.Y.
PROTON RADIATION DAMAGE IN SEMICONDUCTOR DEVICES
J. A. Baicker, H. Flicker, J. Vilms (Applied Research, Camden, N. J.), D. A. Gandolfo, D. M. Arnold, J. R. Parker, and J. Vollmer *In* Atomic Energy Commission. Div. of Tech. Inform., Wash., D.C. Protection Against Radiation Hazards in Space Proc. of the Symp. at Gatlinburg, Tenn., Nov. 5-7, 1962 p 230–242 14 refs (See N63-15114 11-28) OTS: $7.00
(NASA Contract NASI-1654)
(Paper B-5)

The objective of the present study is to interpret observed changes in transistor electrical characteristics in terms of fundamental damage in the semiconductor crystal structure and, in so doing, to predict the effects of proton bombardment. Proton and neutron displacement-production rates are calculated. These are used in conjunction with neutron irradiation data and an assumed similarity of defect clusters to determine the effects of protons on transistors. Reasonable agreement with experiment is obtained. The expected lives of transistors in satellites orbiting in the inner Van Allen belt are given. Author

N63-15161 Stanford Research Inst., Menlo Park, Calif.
A BIBLIOGRAPHY OF BINARY I-VII COMPOUND, VOLUME I Scientific Report No. 2
W. J. Fredericks, F. J. Keneshea, Jr., and F. Craig [1962] 145 p 1352 refs For Vol. II see N63-15162 11-25; for Vol. III see N63-15163 11-25; and for Vol. IV see N63-15164 11-25
(Contract AF 19(604)-7231)
(AFCRL-62-917(I))

This report provides a 1946 to 1961 bibliography of solid-state research on I-VII compounds. The entries are listed under compound and subject. An author index is also included. Author

N63-15162 Stanford Research Inst., Menlo Park, Calif.
A BIBLIOGRAPHY OF GROUP II-VI COMPOUNDS, VOLUME II Scientific Report No. 2
W. J. Fredericks, F. J. Keneshea, Jr., and F. Craig [1962] 126 p 1010 refs For Vol. I see N63-15161 11-25; for Vol. III see N63-15163 11-25; and for Vol. IV see N63-15164 11-25
(Contract AF 19(604)-7231)
(AFCRL-62-917 (II.))

This report provides a convenient 1946 to 1961 bibliography of research on II-VI compounds. The entries are listed under compound and subject. Author

N63-15163 Stanford Research Inst., Menlo Park, Calif.
A BIBLIOGRAPHY OF GROUP III-V COMPOUNDS, VOLUME III Scientific Report No. 2
W. J. Fredericks, F. J. Keneshea, Jr., and F. Craig [1962] 66 p 565 refs For Vol. I see N63-15161 11-25; for Vol. II see N63-15162 11-25; and for Vol. IV see N63-15164 11-25
(Contract AF 19(604)-7231)
(AFCRL-62-917(III))

This report provides a convenient 1946 to 1961 bibliography of research on III-V compounds. The entries are listed under compound and subject. Author

N63-15164 Stanford Research Inst., Menlo Park, Calif.
A BIBLIOGRAPHY OF GROUP IV ELEMENTS AND THEIR COMPOUNDS, VOLUME IV Scientific Report No. 2

W. J. Fredericks, F. J. Keneshea, Jr., and F. Craig [1962] 196 p 1784 refs For Vol. I see N63-15161 11-25; for Vol. II see N63-15162 11-25; and for Vol. III see N63-15163 11-25
(Contract AF 19(604)-7231)
(AFCRL-62-917(IV))

This report provides a convenient 1946 to 1961 bibliography of research on Group IV elements and their compounds. The entries are listed under element and subject. Author

N63-15186 Massachusetts Inst. of Tech. Lab. for Insulation Research, Cambridge
TEMPERATURE AND RISE-TIME DEPENDENCE OF THE ELECTRIC STRENGTH OF ALKALI HALIDE CRYSTALS
Francis W. Kaseta (Ph. D. Thesis) Mar. 1963 25 p 26 refs
(Contract Nonr-1841(10))
(Tech. Rept. 177)

Techniques were developed to extend d.c. and impulse breakdown measurements to liquid-helium temperature. To avoid damage from grinding, an etching method was developed for preparing recessed alkali halide specimens. The breakdown strength of KCl was measured from 4.2° to 425° K with d.c. voltages and 1- and 10-μsec rise-time pulses. The temperature characteristic of the d.c. electric strength reached a maximum of 1.16 Mv/cm at about 360° K and then dropped to 1.04 Mv/cm at 425° K. The breakdown strength was lower for d.c. voltages than for pulses over the entire temperature range. For 1-μsec rise-time pulses, the maximum of the d.c. temperature characteristic disappeared. Below 77° K, the breakdown strength measured with pulse and d.c. voltages did not change appreciably. Changing the pulse rise time from 1- to 20-μsec had little effect on electric strength. No thickness dependence was observed. The electric strength of a mixed crystal (75% KCl-25% RbCl) was measured from 77° to 375° K. The temperature characteristic differed in shape from that of pure KCl; the slope at low temperatures was smaller and the maximum shifted to about 300° K. At 375° K, the breakdown strength of the mixed crystal had dropped to 0.60 Mv/cm. The breakdown strength of helium was measured as a function of pressure at 77° K and at room temperature. For a given pressure, the electric strength of the gas was found to increase by about a factor of 3 when cooled to 77° K. Author

26 PROPELLANTS AND COMBUSTION

Includes: fuels; igniters; and oxidizers.

For related information see: 07 Chemistry; and 27 Propulsion.

N63-14718 Aerojet-General Corp. Chemical Products Div., Azusa, Calif.
PROTOTYPE PROPELLANT-TESTING SYSTEM. PHASE III—DESIGN AND CONSTRUCTION OF CONTAMINANT-INTRODUCTION SYSTEM Final Report, July 13, 1962–Jan. 31, 1963
R. C. Adrian, H. C. Edgington, and F. E. Miller Edwards AFB, Calif., Rocket Prop. Labs., Apr. 1963 79 p 3 refs
(Contract AF 04(611)-8196)
(Rept. 2486; RTD-TDR-63-1024)

A prototype contaminant-introduction system was designed and fabricated for the addition of solid, liquid, and gaseous contaminants to storable or cryogenic propellants maintained under diverse conditions. Five separate units—for the addition of solids, liquids, gases, cryogenic liquids, and vaporized liquids—were constructed and tested to demonstrate their capabilities for adding small amounts of impurities for contamination purposes in the range from 10 ppm to 5000 ppm at accuracies of 6% to 20%. Author

N63-14740 Aeronutronic, Newport Beach, Calif.
STUDY OF DETONATION BEHAVIOR OF SOLID PROPELLANTS Final Technical Report
M. H. Boyer, D. A. Schermerhorn, and H. Uyehara Mar. 30, 1963 115 p 34 refs
(Contract NOw-62-0503-c)
(U-2059)

The proper form of basic equations has been determined, and the development of suitable mathematical techniques for solution of the basic equations has been completed. Mathematical techniques and computer programs have been written and checked out for solving the basic equations in one or two space dimensions and for pressure initiation. It has been concluded that thermally initiated detonation is beyond the capability of the present generation of computers. Experimental data have been obtained on the equation of state parameters for the unreacted solid phase, and similar data for the reacted gaseous products have been obtained from detonation literature. Success has been achieved in demonstrating that theoretically computed detonations generally agree with experimentally observed behavior; the theoretical method has also been used to compute the quantitative initiation behavior of real materials. A.R.B.

N63-14794 Gt. Brit. Ministry of Aviation. Technical Information and Library Services, Mottingham
OPTIMUM DROP DISTRIBUTION IN THE COMBUSTION OF A PARTIALLY VAPORISED FUEL (OPTIMAL'NOE RASPREDELENIE KAPEL'PRI GORENII CHASTICHNO ISPARENNOGO TOPLIVA)
Ya. Basevich Apr. 1963 6 p 3 refs Transl. from Izv. Akad. Nauk SSSR, Otd. Khim. Nauk (Moscow), v. 12, 1959 p 2112-2115
(TIL/T-5386)

A formula previously derived is the basis for obtaining the calculation of the combustion rate of a jet of atomized fuel, drops and vapor for various degrees of prevaporization. It is found that the character of the drop distribution influences the degree of combustion of a partly vaporized fuel. Large values of the constant of distribution raise the rate and degree of combustion of a partly vaporized fuel. Author

N63-14840 Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.
TRANSLATIONAL EFFECTS OF AIR BLAST FROM HIGH EXPLOSIVES Technical Progress Report
I. Gerald Bowen, Paul B. Woodworth, Mary E. Franklin, and Clayton S. White Washington, DASA, Nov. 7, 1962 63 p 15 refs Presented at the Symp. on Effectiveness Analysis Techniques for Non-Nuclear Warheads Against Surface Targets, U. S. Naval Weapons Lab., Dahlgren, Va. Oct. 30, 1962
(Contract DA-49-146-XZ-055)
(DASA-1336)

This report presents for high explosives (free-air burst) the results of a theoretical study—specifically, computed velocity, displacement, and acceleration as functions of time for a variety of objects exposed to blast waves with 12 maximum over pressures ranging from 1 to 20 atm. Although all computations were made for 1 ton of high explosives burst in free air, the results may be readily scaled to lower or higher yields and to surface bursts. The translated objects, or missiles, are identified in this study by their acceleration coefficients which range from 0.01 to 6.0 ft^3/lb. Author

N63-14852 Radiation Applications, Inc., Long Island City, N. Y.
RADIATION-INDUCED SOLID PROPELLANT DECOMPOSITION Technical Documentary Report [1962]
George Odian, Terese Acker, and Thomas Pletzke Jan. 15, 1963 23 p
(Contract AF 49(638)-1125)
(RAI-314)

The broad objective of our research program has been the elucidation of the mechanism of solid-propellant combustion. To this end, both heat and ionizing radiation have been used as reaction initiators. Our specific program has involved the study of: (1) radiation-induced reactions of ammonium perchlorate and (2) thermal reactions of various ammonium perchlorate-organic compound systems. In addition, because of rapidly increasing interests in the field of space, the effects of radiation on the burning rates and tensile strengths of several composite ammonium perchlorate solid propellants have been studied. Author

N63-14904 United Technology Corp., Sunnyvale, Calif.
TURBULENT BOUNDARY LAYER COMBUSTION IN THE HYBRID ROCKET
Gerald A. Marxman and Mitchell Gilbert [1962] 39 p 12 refs Presented at the IXth Intern. Symp. on Combustion, Ithaca, N. Y., Aug. 1962
(Contract NOw 61-1000-c)
(WSS/CI Paper-62-24)

An effort has been made to survey recent theoretical and experimental work related to several aspects of the hybrid combustion process. It has been found that hybrid combustion is controlled by the rate at which heat can be delivered to the fuel surface, rather than by the surface reaction rates. By assuming the combustion occurs in a turbulent boundary layer, a regression rate equation has been developed. This formula is based on the procedures used in other relatively recent studies of heat transfer in reacting boundary layers. Two important factors in this equation are the position of the flame in the boundary layer, and the effective heat of gasification. The regression rate equation predicts the existence and location of the minimum regression rate in a special case where the nonlinear ballistics problem can be treated by an approximate method. This provides a considerable confidence in the underlying assumptions. A theoretical estimate of the regression rate agrees reasonably well with the observed experimental data. Author

N63-15035 Rohm and Haas Co. Redstone Arsenal Research Div., Huntsville, Ala.
OSCILLATORY BURNING OF SOLID COMPOSITE PROPELLANTS
W. A. Wood 32 p 9 refs Presented at the 9th Intern. Symposium on Combustion, Aug. 26–31, 1962
(Contract DA-01-021-ORD-12024)

The interaction of an acoustic oscillatory pressure disturbance with the burning zone of a composite propellant was analyzed. Acoustic waves were found to produce periodic variations in the ratio of the mass release rates of composite propellant components, causing harmonic composition and adiabatic flame temperature fluctuations in the gases above the propellant. These fluctuations may add considerably to the amplification of the acoustic waves; the magnitudes of the amplification effect are particle-size dependent and decreases as the ratio of particle burning time to oscillation period decreases. In contrast to homogeneous propellants, the amplification tendency of composite propellants is apparently not a strong function of the burning rate pressure index of the overall propellant, although composition and flame-temperature may affect double-base propellants at high frequencies. Bands of varying luminosity were observed on the surfaces of propellants burning under the influence of an oscillatory pressure, but the release of these bands has not been clearly related to composition and temperature fluctuation of the gases. M.P.G.

N63-15072 Deutsche Versuchsanstalt für Luft- und Raumfahrt, Mülheim an der Ruhr (W. Germany)
PROBLEME DER FLAMMENFORTPFLANZUNG [THE PROBLEM OF FLAME PROPAGATION]
Wilhelm Jost Dec. 1962 39 p 87 refs In German
(DVL-226)

This review includes: (1) the use of simple models for explaining the phenomena of flame propagation of laminar and turbulent flames; (2) a discussion of several methods for measuring flame velocity; and (3) a bibliography of the most important works in this field. Trans. by I.v.L.

N63-15181 Canadian Armament Research and Development Establishment, Valcartier
CARDE INVESTIGATIONS OF FINITE WAVE AXIAL COMBUSTION INSTABILITY
L. A. Dickinson, W. G. Brownlee and F. Jackson Apr. 1962 17 p 3 refs Presented at the 2nd DOD Technical Panel on Solid Propellant Combustion Instability, Stanford Research Inst., Calif., Mar. 8–9, 1962
(CARDE-TN-1459/62)

Aluminized ammonium perchlorate/polyurethane propellants developed at CARDE have exhibited unstable combustion in the finite-wave axial mode. Experimental work has been performed with 8-inch-diameter, 80-inch-long engines and with quarter-scale (2-in. × 20-in.) engines. The initial aim of the program has been to determine the dependence of unstable combustion on engine operating parameters, engine size, and propellant composition. A pulse technique of initiating unstable combustion, in an engine operating in an incipiently unstable regime, has been used throughout the program. The results of this research program have been applied to the rapid development of a 10-inch-diameter, 125-inch-long engine. Definitive tests have led to guaranteed stable engine performance over the operating temperature range. Author

N63-15192 Deutsche Versuchsanstalt fur Luft- und Raumfahrt Inst. fur Flugtreib- und Schmierstoffe, Munich (W. Germany)
BEITRAG ZUM STUDIUM VON VERBRENNUNGSVORGÄNGEN FLÜSSIGER BZW. GASFÖRMIGER KRAFTSTOFFE MITTELS EMISSIONSSPEKTROSKOPISCHER UNTERSUCHUNGEN [CONTRIBUTION TO THE STUDY OF THE COMBUSTION PROCESS OF LIQUID VERSUS GASEOUS FUELS BY MEANS OF SPECTROSCOPIC-EMISSION ANALYSIS]
Gunter Spengler and Valentin Zanker Nov. 1962 44 p 6 refs In German
(DVL-212)

A study of combustion processes of pure hydrocarbons, alcohols, and hydrocarbon mixtures in a combustion chamber by means of emission spectroscopy is reviewed. Results indicated that the flame spectra of these substances, in the ultraviolet region, were very similar. Intermediate products during the combustion process, which were capable of emission, proved to be the CH-, C_2- and OH-radicals. The concentration differences of these radicals in the combustion zone were considerable so that preliminary statements as to the course of the reaction could be made. At the onset of cyclic unsaturated systems, an additional continuum spectrum glow from solid carbon particles appeared along with the spectra of the radicals. The luminescent temperature of the flame can be considerably lowered by the addition of nitroadditives. In low additive concentrations, only the number of nitro groups per molecule was effective; for example, a tetranitro group was four times as effective as the corresponding mononitro group. During the combustion of hydrocarbons with nitroadditives, additional band groups appeared which were identified as CN bands. I.v.L.

N63-15213 Texaco Experiment Inc., Richmond, Va.
KINETICS OF CONDENSATION FROM THE VAPOR PHASE Final Report
Welby G. Courtney Apr. 14, 1963 63 p 5 refs
(Contract NOnr-3141(00))
(EXP-328; TM-1377)

This program is a theoretical and experimental investigation of the kinetics and mechanisms of condensation and, particularly, of homogeneous nucleation from the vapor phase. Theoretical results are reported for (a) the rate of formation of solid H_2O drops during condensation under constant-volume conditions, (b) the rate of steady-state nucleation from a hypothetical complex vapor system using Li-F data as a base point and arbitrary rate constants, (c) the rate of condensation in generalized B_2O_3 and LiF systems, and (d) the corresponding rates of condensation in certain B-O-H and Li-F systems in a rocket nozzle. Author

N63-15229 California U. Berkeley. Lawrence Radiation Lab.
REACTIVITY LIFETIME AND BURNUP IN NUCLEAR FUELS
Jean Robert Lefebvre de Ladonchamps (Ph. D. Thesis) Jan. 7, 1963 216 p 58 refs
(Contract W-7405-eng-48)
(UCRL-10614) OTS: $3.00

Analytical methods for the prediction of the reactivity lifetime and burnup of nuclear fuels are developed. The analysis applies to those nuclear fuels whose changes in composition with time are due solely to neutron-absorption processes, so that the composition of any fuel species is a function only of the integrated flux time of its irradiation exposure. Reactivity lifetime can then be expressed as a function of the appropriate average flux time of the fuel at the end of the irradiation. Local and average burnup of the irradiated fuel can be calculated without necessarily specifying the magnitude of the irradiation flux or the power program of irradiation. Author

27 PROPULSION

Includes: airbreathing, electric, liquid, nuclear, and solid propulsion.

For related information see: 04 Aircraft; 06 Auxiliary Systems; 26 Propellants and Combustion; and 30 Space Vehicles.

N63-14759 National Advisory Committee for Aeronautics. Lewis Flight Propulsion Lab., Cleveland, Ohio
EMPIRICAL COOLING CORRELATION FOR AN EXPERIMENTAL AFTERBURNER WITH AN ANNULAR COOLING PASSAGE
William K. Koffel and Harold R. Kaufman Washington, NACA, June 26, 1952 33 p 6 refs
(NACA RM E52C13) OTS: $3.60 ph, $1.19 mf (Declassified)

An empirical cooling correlation is established for an experimental high-performance afterburner. For the experimental afterburner investigated, the circumferential average wall temperature could be correlated with a spread from the experimental data of ±50° R over a range of combustion-gas bulk temperature from 1810° to 3500° R. The results of this afterburner are believed representative of most high-performance afterburners. Two other radial distributions of afterburner fuel across the turbine-outlet annulus were investigated and are discussed. Author

N63-14760 National Advisory Committee for Aeronautics. Lewis Flight Propulsion Lab., Cleveland, Ohio
EXPERIMENTAL SEA-LEVEL STATIC INVESTIGATION OF A SHORT AFTERBURNER
James L. Harp, Jr., William E. Mallett, and Thomas B. Shillito Washington, NACA, May 11, 1954 34 p 7 refs
(NACA RM E54B18) OTS: $3.60 ph, $1.22 mf (Declassified)

A sea-level static investigation was conducted to determine the performance and some principles of design for a short afterburner. The power section of a 12-stage axial-flow turbojet engine was used in the investigation, and the afterburner was designed to fit within the length required for the tail pipe used on the standard nonafterburning model. Development of a short afterburner configuration that was considered satisfactory for application was hampered by local hot spots on the outer shell of the afterburner and by screeching combustion. Both the outer-shell hot spots and the screeching combustion were eliminated by use of a perforated liner inside the outer shell, which extended from the flame holder to the exhaust nozzle. One short afterburner configuration incorporating this outer-shell liner gave an augmented thrust 1.33 times that of the standard nonafterburning model of the engine. This augmentation ratio of 1.33 does not represent the maximum augmentation available from the short afterburner, but is the highest that could be obtained with the largest exhaust nozzle available at the time of the investigation. The nonafterburning thrust of this short afterburner configuration was 97 percent of the thrust of the standard nonafterburning model of the engine for the same operating conditions. Author

N63-14761 National Advisory Committee for Aeronautics. Lewis Flight Propulsion Lab., Cleveland, Ohio
ATTENUATION OF TANGENTIAL-PRESSURE OSCILLATIONS IN A LIQUID-OXYGEN-*n*-HEPTANE ROCKET ENGINE WITH LONGITUDINAL FINS
Richard J. Priem Washington, NACA, June 28, 1956 38 p 6 refs
(NACA RM E56C09) OTS: $3.60 ph, $1.34 mf (Declassified)

In an effort to prevent high-frequency combustion-pressure oscillations (screaming), fins were installed in the combustion chamber of a 1000-pound-thrust rocket engine with a chamber pressure of 300 pounds per square inch and using liquid oxygen and *n*-heptane as propellants. Tangential combustion-pressure oscillations were eliminated with longitudinal fins located in the combustion zone. The fin position for the liquid-oxygen - *n*-heptane engine was different from that of the nitric acid - JP-4 fuel system investigated by Theodore Male and William R. Kerslake. With four fins, 4 inches or more in length, complete elimination of the traveling form of the tangential-pressure oscillation was obtained when the fronts of the fins were 3 inches or less from the injector face. With the fronts of the fins located 4 or more inches from the injector face, tangential oscillations were not eliminated; however, the frequency of their occurrence was reduced about 40 percent. The amplitudes of the pressure oscillations were estimated from streak photographs. Fins were relatively ineffective in reducing the amplitude of the pressure oscillations (measured between the injector and fins) in runs where oscillations occurred with fins. Amplitude decreased with increasing chamber length. Unsymmetrical injection patterns were briefly investigated. These injectors had about the same probability of screaming as those with symmetrical injection patterns and the same amplitude of the pressure wave. Author

N63-14971 Argonne National Lab., Ill.
REACTOR DEVELOPMENT PROGRAM Progress Report, Mar. 1963
Albert V. Crewe Apr. 15, 1963 75 p
(Contract W-31-109-eng-38)
(ANL-6705)

Technical progress is reported for the following reactor projects: boiling water reactors, liquid-metal-cooled reactors, reactor technology, plutonium recycle program, advanced systems, and nuclear safety. A bibliography of publications resulting from these studies is included. R.C.M.

N63-15075 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio
TOWARDS THERMONUCLEAR ROCKET PROPULSION
Gerald W. Englert [1962] Repr. from New Scientist (London), v. 16 p 16–18

The concept of controlled thermonuclear fusion is being considered for interplanetary spacecraft propulsion because it promises significant weight and specific impulse advantages over chemical or nuclear fission rockets. The most feasible arrangement uses a mixture of deuterium and helium-3 as the reactor fuel, and superconducting magnets to confine the charged particles and to maintain the high temperature (10^8 to 10^9° K) and density (10^{14} to 10^{15} ions per cubic centimeter) required for the fusion process. The magnets are cooled by a flow of liquid helium, and the heat which the helium absorbs is removed at the cryoplant, so that the only consumption of power in this system is in the cooling plant. The thrust of such a system is estimated at about 1 kw of jet power per pound of engine weight, and the estimated specific impulse is on the order of 10,000 seconds. M.P.G.

N63-15087 Thompson Ramo Woolridge, Inc. New Devices Labs., Cleveland, Ohio

ELECTRON BOMBARDMENT ION SOURCE

Park French N. Y., Am. Rocket Soc. [1962] 7 p Presented at the ARS Electric Propulsion Conf., Berkeley, Calif., Mar. 14–16, 1962

(NASA Contract NAS8-42)

(ARS Paper-2381-62) ARS: $0.50 members, $1.00 nonmembers

A mercury ion source for propulsive use has been developed. The primary development effort on the source has been devoted toward improvement of efficiency and propellant utilization through field and electrode geometry optimization. The present level of performance appears satisfactory for propulsion applications. The source aperture configuration is of particular interest from a propulsion standpoint. The aperture is in the form of a long slit of the order of one millimeter width. This form allows considerable aperture area to be obtained, while allowing close extractor electrode spacing. The close spacing permits well-focused ion beams to be drawn at moderate extraction voltages and also allows the use of massive extractor electrodes. Both of these features are important in obtaining long engine lifetime. The present extraction system is of the accel-decel variety with simple optics, operating at accel-decel ratioos of about 2 to 1. From the standpoint of structural convenience, the present engine has been built around an annular aperture geometry rather than a straight slit geometry. This circular configuration has the advantages of small size and the elimination of end effects in the discharge chamber. It is also expected that the annular beam will prove easier to neutralize than a beam produced by a linear aperture engine. Author

28 SPACE RADIATION

Includes: cosmic radiation; solar flares; solar radiation; and Van Allen radiation belts.

For related information see: 05 Astronomy and Astrophysics; 16 Life Sciences; and 29 Space Sciences.

N63-14786 Naval Research Lab., Washington, D. C.

FISSION PRODUCT RADIOACTIVITY IN THE AIR ALONG THE 80th MERIDIAN (WEST) DURING 1961

L. B. Lockhart, Jr., R. L. Patterson, Jr., A. W. Saunders, Jr., and R. W. Black Jan. 18, 1963 16 p 15 refs

(NRL-5869)

The concentrations of fission-product radioactivity in the atmosphere continued the trend exhibited since the beginning of the moratorium on nuclear testing; namely, a clearly defined seasonal variation in activity at sites in the Northern Hemisphere, together with a less obvious one in the Southern Hemisphere, and a tendency toward equilibration of the activity concentrations in the two hemispheres, through both a slowly decreasing concentration of fission products in the atmosphere north of the equator and an increase south of the equator. Prior to reinitiation of the Soviet nuclear-testing program in September 1961, the natural radioisotope Pb^{210} had become a significant contributor to the total long-lived β activity in the atmosphere. After September 1961, the fission-product radioactivity in the Northern Hemisphere increased a hundredfold or more; a small but measurable transfer of activity to the Southern Hemisphere occurred during the last months of 1961. Author

N63-15086 Iowa State U., Iowa City

CHANGES IN THE STRUCTURE OF THE OUTER RADIATION ZONE ASSOCIATED WITH THE MAGNETIC STORM OF SEPTEMBER 30, 1961

W. G. V. Rosser [1963] 49 p 22 refs

(NASA Grant NsG-233-62)

(SUI-63-7) OTS: $4.60 ph, $1.67 mf

The arrival of solar protons on September 28, 1961, had no observable effect on the distribution and intensity of electrons in the outer radiation zone. Following the magnetic storm of September 30, 1961, a turbulent solar plasma was observed beyond the limits of the outer radiation zone. Evidence is presented which suggests that the outer boundary of the geomagnetic cavity contracted during the period immediately following the storm due to the arrival of excess solar plasma. On October 1, 1961, the radial extent of trapping extended beyond a geocentric distance of 80,000 km. It is suggested that this expansion of the geomagnetic cavity may be due to the presence of a diamagnetic ring current. Following the magnetic storm, the intensity of electrons > 1.6 Mev, detected by the 302 G.M., decreased by a factor 1000 at L = 4.5. The counting rate of the 302 G.M. then increased slowly over a period of days, but had not returned to its prestorm value at L = 4.5 by October 6, 1961. Author

N63-15089 Minnesota U. School of Physics, Minneapolis

OBSERVATIONS OF THE VAN ALLEN RADIATION REGIONS DURING AUGUST AND SEPTEMBER 1959. 6. PROPERTIES OF THE OUTER REGION

R. A. Hoffman (NASA. Goddard Space Flight Center), R. L. Arnoldy, and J. R. Winckler Repr. from J. Geophys. Research, v. 67, no. 12, Nov. 1962 p 4543–4575 25 refs

(NASA Contract NASw-56)

This last in a series of six papers summarizing the results of measurements with ion chamber and Geiger counter instruments aboard the Explorer VI satellite discusses the general intensity, structure, and shape of the outer radiation region as displayed by contours of constant counting rate from the Anton Geiger counter. These contour plots show the large variation in counting rate, volume, and structure to which the outer radiation region is subjected during magnetic activity. It is concluded that major intensity changes always correlate with solar activity, a time delay indicating the coupling by means of solar plasma beams. Intensity changes are independent of the occurrence of a Forbush type decrease caused by the plasma cloud. Counting-rate changes during storms mainly associated with energetic electrons near 1 Mev are observed. Counting rates near the equator decrease for all lines of force if the storm has a main phase. Sometimes the decrease near the equator is accompanied by an increase near the atmosphere showing the lowering of mirror points. The percentage decreases are larger for lines of force at large radial distances. Large decreases on all lines of force are accompanied by widespread aurora. Counting rate increases occur during the recovery phase of magnetic storms and are apparently due to a local acceleration mechanism. The increased flux consists of particles having large pitch angles with a spectrum similar to that of the prestorm conditions. This paper includes a summary of conclusions from all six papers in the series. Author

N63-15091 Minnesota U. School of Physics, Minneapolis

OBSERVATION OF THE VAN ALLEN RADIATION REGIONS DURING AUGUST AND SEPTEMBER, 1959 4. THE OUTER-ZONE ELECTRONS

R. L. Arnoldy, R. A. Hoffman, and J. R. Winckler Repr. from J. Geophys. Research, vol. 67, no. 7, July 1962 p 2595–2612 20 refs Previously processed as Tech. Rept. CR-51; see N63-11303 03-28

(NASA Contract NASw-56)

A study is reported of the data from the radiation detectors aboard the Explorer VI earth satellite launched August 7, 1959, as the spacecraft passed through the outer zone during a period when the count-rate time variations and the geomagnetic activity were low. The radiation detectors aboard the satellite were an ionization chamber, a Geiger counter, a proportional-counter telescope, and a scintillator. Extensive calibrations were made to determine the response of these detectors to monoenergetic electrons when inside a spare payload. In using these calibrations and fitting assumed power-law spectra of electrons to the data, it is seen that the spectrum is flat and must extend to several Mev at the small ranges, with the ion chamber and Geiger counter responses there due primarily to direct electron detection. The intensity of the energetic electrons is shown to decrease with increasing range as the spectra steepen and the radiation softens, resulting in an increasing contribution of bremsstrahlung to the rates of the chamber and Geiger counter. Any attempt to utilize the bremsstrahlung response of the Explorer VI detectors to determine fluxes is useless if an appreciable portion of their counting rate is produced by direct energetic particles. The spectral shape of the outer zone as suggested by this analysis allows us to interpret the minimum observed in the Geiger counter rate at an equatorial geocentric range of 19,000 km as having spectral-detector origin rather than as representing the removal of radiation by an anomaly in the earth's magnetic field. This analysis is only capable of fitting trial spectra to the data; the procedure does not eliminate the possibility of more complex spectra existing in the outer zone, which would lead to different conclusions about the nature of the trapped radiation. Author

N63-15114 Atomic Energy Commission. Div. of Technical Information, Washington, D.C.

PROTECTION AGAINST RADIATION HAZARDS IN SPACE, BOOK I Proceedings of the Symposium at Gatlinburg, Tenn., Nov. 5-7, 1962

[1962] 427 p 337 refs

(Sponsored by NASA. Manned Spacecraft Center, Oak Ridge Natl. Lab., and American Nuclear Soc.)

(TID-7652, Bk. 1) OTS: $7.00 for Books I and II

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N63-15115 National Aeronautics and Space Administration, Washington, D.C.

THE MISSION OF MAN IN SPACE

Homer E. Newell *In* Atomic Energy Commission. Div. of Tech. Inform., Wash., D.C. Protection Against Radiation Hazards in Space Proc. of the Symp. at Gatlinburg, Tenn., Nov. 5-7, 1962 p *vii–xvii* (See N63-15114 11-28) OTS: $7.00

Man's mission in space exploration is reviewed. The various aspects of man in orbit, on the moon, around the moon, in interplanetary space, and on other planets are discussed with special emphasis placed on the means of protecting man against the radiation hazards of space. D.E.R.

N63-15116 Iowa State U., Iowa City
BRIEF NOTE ON THE RADIATION BELTS OF THE EARTH
J. A. Van Allen *In* Atomic Energy Commission. Div. of Tech. Inform., Wash., D.C. Protection Against Radiation Hazards in Space Proc. of the Symp. at Gatlinburg, Tenn., Nov. 5–7, 1962 p 1–11 7 refs (See N63-15114 11-28) OTS: $7.00
(Paper A-1)

The positional dependence of the absolute intensity of several selected components of the trapped particle population of the earth's radiation belts is graphically summarized. D.E.R.

N63-15117 Minnesota U., Minneapolis
AN EVALUATION OF THE RADIATION HAZARD DUE TO SOLAR COSMIC RAYS
W. R. Webber and P. S. Freier *In* Atomic Energy Commission. Div. of Tech. Inform., Wash., D.C. Protection Against Radiation Hazards in Space Proc. of the Symp. at Gatlinburg, Tenn., Nov. 5–7, 1962 p 12–32 7 refs (See N63-15114 11-28) OTS: $7.00
(Paper A-2)

Some general characteristics of solar cosmic ray radiation are discussed and defined to aid in the understanding of galactic cosmic radiation and its effect on space radiation levels and space probes. Included are: the intensity-time profile, anisotropy in the flare particles, flare particle energy spectrum and charge composition, and the specific features of some features of some important solar cosmic events. D.E.R.

N63-15118 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
COMPOSITION OF SOLAR COSMIC RAYS
C. E. Fichtel *In* Atomic Energy Commission. Div. of Tech. Inform., Wash., D.C. Protection Against Radiation Hazards in Space Proc. of the Symp. at Gatlinburg, Tenn., Nov. 5–7, 1962 p 33–43 12 refs (See N63-15114 11-28) OTS: $7.00
(Paper A-3)

The energetic solar particles arriving at the earth after disturbances on the sun are discussed with respect to their composition. It is known that the primary constituent of solar rays is hydrogen nuclei, but the relative abundance of the less plentiful components, namely, helium nuclei, heavier nuclei, electrons, and gamma rays, is not known for certain. However, within the scope of present knowledge, ratios for the concentrations of these particles are defined. D.E.R.

N63-15119 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
DETAILS OF INDIVIDUAL SOLAR PARTICLE EVENTS
Carl E. Fichtel, Donald E. Guss, and K. W. Ogilvie *In* Atomic Energy Commission. Div. of Tech. Inform., Wash., D.C. Protection Against Radiation Hazards in Space Proc. of the Symp. at Gatlinburg, Tenn., Nov. 5–7, 1962 p 44–85 76 refs Repr. from *its* External Document X-611-62-122 (See N63-15114 11-28) OTS: $7.00
(Paper A-4)

A time history of the intensities and energies of solar cosmic ray particles detected at or near the earth is presented. An approximate energy spectrum of the proton component as a function of time is given. The various detectors used to study the solar particles, the riometer, neutron monitor, and direct primary particle detectors, are described, and significant features of the major solar particle events are discussed. An imaginary event is proposed that encompasses all the types of events discussed. D.E.R.

N63-15120 National Bureau of Standards, Boulder, Colo.
INFORMATION ON SOLAR PROTON EVENTS (PCA'S) DEDUCED FROM RADIO OBSERVATIONS
D. K. Bailey *In* Atomic Energy Commission. Div. of Tech. Inform., Wash., D.C. Protection Against Radiation Hazards in Space Proc. of the Symp. at Gatlinburg, Tenn., Nov. 5–7, 1962 p 86–87 (See N63-15114 11-28) OTS: $7.00
(Paper A-5)

Recent contributions of ionospheric workers that have used new techniques for radio observations from fixed positions in studying solar proton events are discussed. With this technique, the incoming protons are not observed directly, but the effects on the propagation of waves resulting from abnormal ionization produced by the protons are observed. These radio observation techniques yield quantitative information about the onset and duration times of the events, isotropy departures of the arriving protons, the instantaneous spectrum, and the time variation of the event. Thus, it seems that this fixed radio observation technique is better to discover: (1) the frequency of occurrence of solar proton events; (2) the statistics of occurrence of solar proton events of different magnitudes; (3) the statistics of departures from pure proton fluxes; (4) statistics of departure from isotropy in space; (5) the predictability of discrete events; and (6) the limitations of predictability. Therefore, this technique contributes greatly to the study of radiation hazards posed by solar proton events. D.E.R.

N63-15121 North American Aviation Inc., Downey, Calif.
STATISTICAL PREDICTION OF SOLAR EVENTS
James B. Weddell *In* Atomic Energy Commission. Div. of Tech. Inform., Wash., D.C. Protection Against Radiation Hazards in Space Proc. of the Symp. at Gatlinburg, Tenn., Nov. 5–7, 1962 p 88–95 11 refs (See N63-15114 11-28) OTS: $7.00

A method of correlating solar flares in time with several indices of activity of solar regions is described. The method determines the probability of occurrence of a flare, if each of two indices exceeded given limits, and the average time between measurement of these indices and the outbreak of the flare. Significant correlations are listed; the most important is the tendency for major flares to occur in the second passage across the solar disk of regions exceeding 2000 millionths of the solar hemisphere in area, and which gave rise to small flares during their first passage. These criteria permit prediction of 69% of class-3 flares at least 14 days in advance. Flare positions have been correlated with the magnetic field in active regions. The field near the sites of flares tends to be frozen into the solar atmosphere to a greater extent than other portions of the field. Author

N63-15122 Northrop Space Labs., Hawthorne, Calif.
COMMENTS ON THE PRODUCTION OF SOLAR HIGH ENERGY PARTICLES
M. C. Chapman, R. E. Fortney, and M. R. Morrison *In* Atomic Energy Commission. Div. fo Tech., Inform., Wash., D.C. Protection Against Radiation Hazards in Space Proc. of the Symp. at Gatlinburg, Tenn., Nov. 5–7, 1962 p 96–117 15 refs (See N63-15114 11-28) OTS: $7.00
(Paper A-7)

A general qualitative model for the production of solar high-energy particles (SHEP) which can explain sereral observed flare phenomena is used in the analysis of a specific flare event. The model, incorporating the work of several Russians and Americans, explains the occurrence of solar radio emission, the initial anisotropic and later isotropic distribution of flare particles, Forbush decreases in cosmic-ray intensity, decreases in cosmic radio noise, and fluctuations in the earth's magnetic field due to solar-flare particles. Also qualitatively explained are such phenomena as the occurrence of shock waves during flare events, observed surges in the active region, and movement of magnetic "bumps" before the start of the flare. Author

N63-15132 Brookhaven National Lab., Upton, N. Y.
SOME SPECIFIC CONSIDERATIONS OF THE POTENTIAL HAZARDS OF HEAVY PRIMARY COSMIC RAYS
Howard J. Curtis *In* Atomic Energy Commission. Div. of Tech. Inform., Wash., D.C. Protection Against Radiation Hazards in Space Proc. of the Symp. at Gatlinburg, Tenn., Nov. 5–7, 1962 p 291–308 8 refs (See N63-15114 11-28) OTS: $7.00
(Supported by the AEC)
(Paper C-3)

An indirect method, using a microbeam of deuterons, for studying the problem of radiation by stripped atomic nuclei of atoms that are as heavy as iron in galactic cosmic rays is presented. By localized irradiation techniques, the effect of such particles has been approximated for varius bodily organs and for the whole body; it is seen that their effect is highly concentrated on single tracks, with high localized concentrations. The radiation causes very little effect in either the brain or the eye, or other vital organs, but will cause greying of the hair. It is concluded that this type of radiation is not a serious hazard for space flight. D.E.R.

N63-15136 Naval School of Aviation Medicine, Pensacola, Fla.
LET SPECTRUM AND RBE OF HIGH ENERGY PROTONS
Hermann J. Schaefer *In* Atomic Energy Commission. Div. of Tech. Inform., Wash., D. C. Protection Against Radiation Hazards in Space Proc. of the Symp. at Gatlinburg, Tenn., Nov. 5–7, 1962 p 393–401 13 refs (See N63-15114 11-28) OTS: $7.00

High-intensity proton radiations in space, temporarily superimposed upon the ordinary cosmic-ray beam, have energy spectra extending from a few to many hundred Mev. Analysis of the LET spectrum of a typical flare-produced proton beam shows that the bulk of the energy dissipation is effected with an LET spectrum closely resembling that of standard X-rays. A basic difference exists in the spectral region beyond 10 Kev/micron tissue. Though the fractional dose in that region expressed in rad remains on the level of a few percent, it represents a significant part of the total rem dose. It is suggested that both dose fractions be treated separately in assessing the ERD (Equivalent Residual Dose), with the recovery allowance of 2.5 percent per day applicable only to the low LET fraction. Author

N63-15138 Atomic Energy Commission. Div. of Technical Information, Washington, D.C.
PROTECTION AGAINST RADIATION HAZARDS IN SPACE, BOOK II Proceedings of the Symposium at Gatlinburg, Tenn., Nov. 5-7, 1962
[1962] 475 p 242 refs
(Sponsored by NASA. Manned Spacecraft Center, Oak Ridge Natl. Lab., and American Nuclear Soc.)
(TID-7652, Bk. 2) OTS: $7.00 for Books I and II

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40. THE PROSPECTS FOR ACTIVE SHIELDING R. H. Levy (Avco-Everett Res. Lab.) p 794–807 4 refs Previously processed as N63-13354 08-23
41. SHIELDING OF SPACE VEHICLES BY MAGNETIC FIELDS N. Edmonson, C. D. Verwers, and F. L. Gibbons (Gen. Dyn./Ft. Worth) p 808–818 10 refs (See N63-15155 11-32)
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44. SOME EXPERIMENTS ON THE PASSAGE OF HIGH-ENERGY PROTONS IN DENSE MATTER S. P. Shen (New York U.) p 852–865 23 refs (See N63-15158 11-28)

45. THE BIOLOGICAL HAZARDS OF π AND μ MESONS
B. L. Murphy, P. Kitching, and H. B. Knowles (Yale U.) p 866–875 6 refs (See N63-15159 11-16)

N63-15143 Oak Ridge National Lab., Tenn.
A SERIES OF MONTE CARLO CODES TO TRANSPORT NUCLEONS THROUGH MATTER
W. E. Kinney, R. R. Coveyou, and C. D. Zerby *In* Atomic Energy Commission. Div. of Tech. Inform., Wash., D. C. Protection Against Radiation Hazards in Space Proc. of the Symp. at Gatlinburg, Tenn., Nov. 5–7, 1962 p 608–618 5 refs (See N63-15138 11-28) OTS: $7.00

A series of Monte Carlo codes for the IBM-7090 computer has been written to transport nucleons of energy less than 400 Mev through complex configurations composed of four or fewer materials. The nucleons above 50 Mev are treated by a high-energy transport code which uses an intranuclear cascade subroutine to compute the production of secondary nucleons. Below 50 Mev, protons are allowed to proceed straight ahead with no nuclear interactions, and neutrons are transported by the already existing 05R code. Doses in tissue behind aluminum slabs of varying thickness, estimated from 1940 400-Mev source protons and their descendant, showed the primary beam dose to be more than a factor of two larger than the dose due to all secondaries. Author

N63-15149 California U., Berkeley. Lawrence Radiation Lab.
TRANSPORT CALCULATIONS FOR PROTON SHIELDING
Gerald Litton, Rubin Goldstein, and Roger Wallace *In* Atomic Energy Commission. Div. of Tech. Inform., Wash., D.C. Protection Against Radiation Hazards in Space Proc. of the Symp. at Gatlinburg, Tenn., Nov. 5–7, 1962 p 713–717 4 refs (See N63-15138 11-28) OTS: $7.00
(Paper E-4)

To calculate the dose rate and integrated dose behind a layer of material that shields against a proton flux, it is necessary to know the effect of the shield on the incident flux. The work reported here investigates that effect. The analysis takes into account both proton-ionization-energy loss and secondary-particle production, using the transport method of successive generations. The secondaries considered are protons, neutrons, and π mesons. Author

N63-15150 Oak Ridge National Lab., Tenn.
COMPARISON OF PRIMARY PROTON DOSE WITH THE DOSE FROM GAMMA RAYS PRODUCED BY INELASTIC SCATTERING OF SOLAR FLARE PROTONS
F. S. Alsmiller, R. G. Alsmiller, Jr., and D. K. Truber *In* Atomic Energy Commission. Div. of Tech. Inform., Wash., D.C. Protection Against Radiation Hazards in Space Proc. of the Symp. at Gatlinburg, Tenn., Nov. 5–7, 1962 p 718–724 13 refs (See N63-15138 11-28) OTS: $7.00
(Paper E-5)

The primary proton dose resulting from solar-flare (May 10, 1959) protons incident on an aluminum shield is compared with the dose from gamma rays produced by inelastic collisions of the primary protons. Both spherical shell and slab shields are considered. Author

N63-15158 New York U., N.Y.
SOME EXPERIMENTS ON THE PASSAGE OF HIGH-ENERGY PROTONS IN DENSE MATTER
S. P. Shen *In* Atomic Energy Commission. Div. of Tech. Inform., Wash., D.C. Protection Against Radiation Hazards in Space Proc. of the Symp. at Gatlinburg, Tenn., Nov. 5–7, 1962 p 852–865 23 refs (See N63-15138 11-28) OTS: $7.00
(Paper F-5)

A series of experiments designed to study the nuclear cascade resulting from the passage of 1 to 3 Gev protons in matter has been in progress at the Brookhaven Cosmotron. Preliminary results on the fluxes of fast neutrons (upper limits) and of strongly interacting particles above 50 Mev are summarized. The four cases studied are: 1-Gev protons on Fe, on chondritic material, and on $C_6H_8O_2$, and 3-Gev protons on Fe. Author

29 SPACE SCIENCES

Includes: space chemistry; cosmology; lunar and planetary exploration; and theoretical analysis of orbits and trajectories.

For space biology see: 16 Life Sciences.

For related information see: 05 Astronomy and Astrophysics; 12 Geophysics; and 22 Navigation and Guidance.

N63-14717 Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
DESIGN PARAMETERS FOR BALLISTIC INTERPLANETARY TRAJECTORIES. PART I. ONE-WAY TRANSFERS TO MARS AND VENUS
V. C. Clarke, Jr., W. E. Bollman, R. Y. Roth, and W. J. Scholey Jan. 16, 1963 419 p 7 refs
(NASA Contract NAS7-100)
(JPL-TR-32-77) OTS: $22.25 ph, $12.77 mf

The general characteristics of ballistic interplanetary trajectories are discussed, and detailed equations are developed for the analytical model. Extensive data are presented in graphical form for trajectories to Venus (1962–1970) and Mars (1962–1977). These 313 graphs include: (1) curves of *vis viva* geocentric energy vs. launch date for minimum-energy trajectories, and (2) curves of 18 different trajectory parameters vs. launch date for various *vis viva* geocentric energies. The trajectories were computed on the IBM-7090 digital computer by numerical evaluation of the analytical model, after which specific parameters of interest were automatically plotted, carefully checked, and analyzed. Procedures are outlined for use of these data by the trajectory engineer in the design and analysis of interplanetary trajectories. Author

N63-14739 Lockheed Missiles and Space Co., Sunnyvale, Calif.
ANNOTATED BIBLIOGRAPHY OF LUNAR PROPERTIES, GEOLOGY, VEHICLES, AND BASES. PART III: LUNAR AND ARCTIC EXPLORATION AND HABITATION
A. A. Beltran, J. B. Goldmann, and E. E. Graziano, comps. Feb. 1962 355 p 813 refs
(Spec. Bibl. SB-61-67; AD 273-136)

Part III, the final part of the lunar bibliography, is concerned with fixed and mobile lunar bases, construction problems, lunar surface vehicles, methods and feasibility of human habitation, establishment of lunar colonies, and ground support equipment. Arctic and Antarctic exploration, including base construction, surface vehicles, clothing and equipment, and environmental effects on man is included because of its applicability to lunar bases and exploration. Author

N63-14782 National Aeronautics and Space Administration. Goddard Inst. for Space Studies, New York, N.Y.
NEUTRINO PROCESSES AND RED GIANTS
Hont-Yee Chiu (Columbia U.) Repr. from Astrophys. J., v. 137 no. 1, Jan. 1963 p 343–344 3 refs

Neutrino processes involving (ev) (ev) coupling, those processes that are important in the later stages of stellar evolution where other neutrino processes become inactive, have been applied at low temperatures (down to $T = 10^8$ °K) and high density ($\rho = 10^7$ gm/cm^3). These processes are important during the gravitational contraction phase of a degenerate stellar core and in the

evolution to the white dwarf stage. It is also suggested that the importance of the neutrino processes should not be neglected in future studies of red giant models. D.E.R.

N63-14806 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

SOME POSSIBILITIES FOR DETERMINING THE CHARACTERISTICS OF THE ATMOSPHERES OF MARS AND VENUS FROM GAS-DYNAMIC BEHAVIOR OF A PROBE VEHICLE

Alvin Seiff Washington, NASA, Apr. 1963 36 p 12 refs
(NASA TN D-1770) OTS: $1.00

One of the early objectives of space probes sent to Mars and Venus will be to determine the characteristics of the atmospheres on those planets for scientific purposes. Characteristics of interest include profiles of gas density, temperature, and pressure above the planet surface, and chemical composition of the atmosphere. It is found that the density, pressure, and RT product profiles in the atmosphere can be obtained from measurements of axial acceleration and the angle-of-entry into the atmosphere. For a certain class of entry-body configurations, measurements of the static flight stability can be used to give information on the mean ratio of specific heats of the atmospheric gases. Measuring the ambient temperature so as to obtain the gas constant R from its product with temperature, RT, and hence determine the mean molecular weight of the atmospheric gases is discussed. Luminosity detectors that view the excited high-temperature gases in the probe shock layer for evidence of composition are discussed, as well as the possibility of determining the kind of gases from measurements of stagnation temperatures. An important characteristic of this kind of probe experiment is that the definition of atmospheric properties begins as high in the atmosphere as any detectable effect on the probe occurs—in general, around 300,000-feet altitude. Author

N63-14856 Aeronautical Chart and Information Center, St. Louis, Mo.

SPACE REFERENCE SYSTEMS Interim Report

Edward M. Thompson Apr. 1962 25 p 9 refs
(ACIC-TR-98)

This paper presents systems which can be used in different phases of space flight. The following coordinate systems are described: (a) Geocentric System, (b) Heliocentric System, (c) Selenographic System, (d) Planetographic System, and (e) Inertial System. For the initial phase of a flight, the earth-centered, geocentric system may be used. The midcourse phase of the flight begins when the earth's gravitational force is no longer predominant. At this point, the reference system can be changed to heliocentric or inertial. As the vehicle approaches the target, the selenographic or planetographic system may be used. The selenographic system is centered at the center of the moon, and the planetographic system can be based on the center of any planet. Procedures involved in transition from one system to another are developed under a section on coordinate transformations. Various disturbing or perturbing effects are discussed, and the possible effects on a space vehicle and its instantaneous reference system are described. Author

N63-14861 Centre National d'Études Spatiales, Paris (France)

PROGRAMME D'ÉTUDES TECHNIQUES SPATIALES, 1963-1965 [PROGRAM OF SPACE TECHNIQUES STUDIES, 1963-1965]

M.J. Voge 1963 37 p In French

The current status of space technology in France is assessed, and priorities are assigned in the projected 1963 to 1965 French space program in the following categories: propulsion, materials and structures, power and auxiliary systems, optical and scientific instrumentation, information processing, telecommunications and tracking, guidance and stabilization, environmental studies, advanced missions, and electronic components. M.P.G.

N63-14888 North American Aviation Inc. Space and Information Systems Div., Downey, Calif.

LOGISTICS FUNCTIONS IN ENGINEERING DEVELOPMENT

D. Amorelli, R. F. Wadsworth, and G. O. Moseley, Jr. Oct. 1, 1962 23 p 5 refs For presentation at the Natl. Large Rocket Symp. of the Inst. of Aerospace Sci., Sacramento, Oct. 29–30, 1962

Traditional logistics functions are examined and the immediate need for a team composed of the design, reliability, and logistics engineers is established. This team's success requires professional acceptance of logistics engineers as coequals by other engineering groups. Possible methods for obtaining this acceptance are discussed. Logistics functions in engineering development of boosters and other advanced programs are examined, commencing with feasibility studies and progressing through contract negotiations to operational phases. Author

N63-14896 Dayton U. Research Inst., Ohio

WEIGHTLESS MAN: SELF-ROTATION TECHNIQUES [Final Report, Nov. 1961-Feb. 1962]

Philip V. Kulwicki, Paul L. Vergamini, and Edward J. Schlei Wright-Patterson AFB, Ohio, Behavioral Sciences Lab., Oct. 1962 44 p 10 refs
(Contract AF 33(616)-6256)
(AMRL-TDR-62-129) OTS: $1.25

The purpose of this study was to investigate the possibility of body rotation by limb manipulation. This self-rotation is analyzed by the application of theoretical mechanics to a rigid mathematical model composed of six cylindrical segments. A quantitative evaluation, based on the mathematical model, is made for one maneuver to determine the expected degree of rotation. As a result of this analysis, a series of selected maneuvers are proposed to give man the capability for rotation about three mutually perpendicular axes. The nine maneuvers are intended to provide an effective rotation, while reducing undesirable coupled rotations. In addition, the stability of rotation of various geometrical shapes is investigated to determine if man can expect a self-rotation maneuver to be stable. Author

N63-14902 Jet Propulsion Lab. Calif. Inst. of Tech., Pasadena

SPACE PROGRAMS SUMMARY NO. 37-19, VOLUME VI FOR THE PERIOD NOVEMBER 1, 1962 TO JANUARY 31, 1963. SPACE EXPLORATION PROGRAMS AND SPACE SCIENCES

Feb. 28, 1963 101 p 9 refs
(NASA Contract NAS7-100)
(JPL-SPS-37-19, Vol. VI) OTS: $9.10 ph, $3.23 mf

Space exploration programs and space science studies are summarized. The lunar program, planetary-interplanetary program, deep space instrumentation facility, and operational and test facilities are described. D.E.R.

N63-14943 Iowa State U., Iowa City

MARINER II: PRELIMINARY REPORTS ON MEASUREMENTS OF VENUS

L. A. Frank, J. A. Van Allen, and H. K. Hills Repr. from Science, v. 139, no. 3558, Mar. 8, 1963 p 905–907 4 refs
(NASA Grant NsG-233-62)

The Mariner II spacecraft successfully completed its 109-day journey through interplanetary space and, on 14 December 1962, passed Venus at a minimum distance of approach to the planet's center of 41,000 kilometers (6.6 radii of the solid body of the

planet). The achievement permitted the first *in situ* scientific measurements in the vicinity of any planet other than Earth. The results of some of these measurements are reported. Author

N63-14984 Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
UTILIZATION OF EXTRATERRESTRIAL RESOURCES Seminar Proceedings, Sept. 25-26, 1962
Apr. 1, 1963 38 p 28 refs Presented at the Meeting of the Working Group on Extraterrestrial Resources, Wash., D. C., Sept. 25-26, 1962
(NASA Contract NAS7-100)
OTS: $3.60 ph, $1.34 mf

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2. HYDROPONICS OR SOILLESS CULTURE H. D. Chapman (California U.) p 10-15 18 refs (See N63-14986 11-29)
3. PROCESSING OF WATER ON THE MOON A. A. Fowle (Arthur D. Little Co.) p 16-18 (See N63-14987 11-29)
4. LUNAR BASE CONSTRUCTION G. W. Johnson (Jet Propulsion Lab.) p 19-20 (See N63-14988 11-29)
5. LUNAR ROCKS AS A SOURCE OF OXYGEN H. G. Poole (Colorado School of Mines) p 21-25 (See N63-14989 11-29)
6. WATER IN LUNAR MATERIALS Robert C. Speed (Jet Propulsion Lab.) p 26-32 6 refs (See N63-14990 11-29)
7. SUMMARY OF APOLLO AND LUNAR LOGISTICS SYSTEM PLANS W. B. Taylor (NASA) p 33 (See N63-14991 11-29)

N63-14985 RAND Corp., Santa Monica, Calif.
STATUS OF DESIGNS OF LUNAR SURFACE VEHICLES
P. H. Bliss *In* Jet Propulsion Lab., Calif. Inst. of Tech. Utilization of Extraterrestrial Resources Seminar Proceedings, Sept. 25-26, 1962 Apr. 1, 1963 p 1-9 4 refs (See N63-14984 11-29) OTS: $3.60 ph, $1.34 mf

The designs of several lunar surface vehicles are discussed with regard to their type, size, type of traction, and motive power. A description of their body styles, and accessory provisions and performance details, where available, are presented. D.E.R.

N63-14986 California U., Riverside
HYDROPONICS OR SOILLESS CULTURE
H. D. Chapman *In* Jet Propulsion Lab., Calif. Inst. of Tech. Utilization of Extraterrestrial Resources Seminar Proceedings, Sept. 25-26, 1962 Apr. 1, 1963 p 10-15 18 refs (See N63-14984 11-29) OTS: $3.60 ph, $1.34 mf

The science of growing foodstuffs in soilless cultures (hydroponics) is reviewed: the historical origin, use, and applicability to extraterrestrial environments. The future of hydroponics is predicted on the basis of ever-growing populations. D.E.R.

N63-14987 Little (Arthur D.) Inc., Cambridge, Mass.
PROCESSING OF WATER ON THE MOON
A. A. Fowle *In* Jet Propulsion Lab., Calif. Inst. of Tech. Utilization of Extraterrestrial Resources Seminar Proceedings, Sept. 25-26, 1962 Apr. 1, 1963 p 16-18 (See N63-14984 11-29) OTS: $3.60 ph, $1.34 mf

The processing of water by electrolysis and liquefaction are reviewed for lunar applications. It is shown that a great deal of research is needed to develop lightweight, efficient, reliable systems for the processing of water to liquid hydrogen and oxygen to define the characteristics of a near-optimum system. D.E.R.

N63-14988 Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
LUNAR BASE CONSTRUCTION
G. W. Johnson *In its* Utilization of Extraterrestrial Resources Seminar Proceedings, Sept. 25-26, 1962 Apr. 1, 1963 p 19-20 (See N63-14984 11-29) OTS: $3.60 ph, $1.34 mf

The possibility of establishing a permanently manned lunar base is discussed and the various design features are appraised. Supply and transportation problems are presented and means of circumventing them are reviewed. D.E.R.

N63-14989 Colorado School of Mines, Golden
LUNAR ROCKS AS A SOURCE OF OXYGEN
H. G. Poole *In* Jet Propulsion Lab., Calif. Inst. of Tech. Utilization of Extraterrestrial Resources Seminar Proceedings, Sept. 25-26, 1962 Apr. 1, 1963 p 21-25 (See N63-14984 11-29) OTS: $3.60 ph, $1.34 mf

A thermodynamic study of the thermal stability of conventional terrestrial minerals in a hypothetical lunar atmosphere has led to the speculation that quartz and other silicates would decompose to form spinels and other alumina-bearing materials under lunar atmospheric conditions. But the spinel crust should be superficial, according to pressure studies. If quartz persists at moderate depths, it could be mined and used as a source of oxygen to support life on the moon. The same hypothesis holds for other oxides. D.E.R.

N63-14990 Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
WATER IN LUNAR MATERIALS
Robert C. Speed *In its* Utilization of Extraterrestrial Resources Seminar Proceedings, Sept. 25-26, 1962 Apr. 1, 1963 p 26-32 6 refs (See N63-14984 11-29) OTS: $3.60 ph, $1.34 mf

Evidence suggests that the materials which formed the moon were not anhydrous. Meteorites contain water, in varying amounts, as well as silicate hydrates. Water should reach the moon by gas emission, just as it reaches the earth's surface. The water could possibly occur in crystalline hydrates, glasses, adsorbed water, pore water, and surface condensates. Several methods of exploration for lunar water are suggested, including: spectral analysis from an orbiting vehicle, ground-based geophysical surveys, neutron albedo, qualitative indicators of hydrous rocks, and conventional petrologic instrumentation. D.E.R.

N63-14991 National Aeronautics and Space Administration, Washington, D.C.
SUMMARY OF APOLLO AND LUNAR LOGISTICS SYSTEM PLANS
W. B. Taylor *In* Jet Propulsion Lab., Calif. Inst. of Tech. Utilization of Extraterrestrial Resources Seminar Proceedings, Sept. 25-26, 1962 Apr. 1, 1963 p 33 (See N63-14984 11-29) OTS: $3.60 ph, $1.34 mf

The Apollo project and lunar logistics-system plans are summarized. D.E.R.

N63-15039 Melpar Inc., Falls Church, Va.
DETECTION OF EXTRATERRESTRIAL LIFE. METHOD II: OPTICAL ROTATORY DISPERSION First Quarterly Report, 20 Dec. 1962 to 19 Mar. 1963
[1963] 24 p
(NASA Contract NASw-557)
OTS: $2.60 ph, $0.92 mf

Optical-rotation measurements performed on a water-soluble extract of soil have indicated a cotton effect at about 255 mμ. In addition, ultraviolet absorption measurements on this extract have shown that this approach is not as sensitive as rotatory dispersion for characterizing unknown mixtures. A new system, the ratio of a difference to a constant, has been developed which should permit

measurement of optical rotations in the cotton region for both turbid and homogenous solutions. The theoretical development of this technique indicates that it may be possible to determine the difference in absorption coefficients associated with circular dichroism. The Cary spectrophotometer, model 15, is now being modified for this purpose. Author

N63-15052 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

PREDICTION OF VELOCITY REQUIREMENTS FOR MINIMUM TIME ABORTS FROM THE MIDCOURSE REGION OF A LUNAR MISSION

Robert B. Merrick and George P. Callas Washington, NASA, Apr. 1963 40 p 7 refs
(NASA TN D-1655) OTS: $1.00

Problems associated with quick returns to the earth from the midcourse region of a lunar mission have been examined by relating errors in perigee height to some of the errors inherent in any abort maneuver. Four sources of error, other than the two-body approximation effects, were considered, and their influence upon the perigee height at return was examined statistically. These error sources are the inaccuracy in the knowledge of position and velocity at abort and the inaccuracies in the magnitude and aiming of the abort rocket. The aiming error in the thrust applied during abort was responsible for major perigee deviations. The velocity increments necessary to correct the errors incurred by the abort maneuver were computed at various points on the return trajectory. Less than 5 percent of the abort velocity increment is sufficient to correct these errors if the correction is applied at a range of 100,000 km from the earth. Author

N63-15165 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

NASA FACILITY FOR THE STUDY OF SPACE RADIATION EFFECTS

David R. Johnson [1963] 18 p 5 refs Presented at The Institute of Electrical and Electronics Engineers Region 3 Meeting, Richmond, Va., Apr. 24–26, 1963
(Paper CP 63-678)

Space particulate radiation from the Van Allen belts, solar flares, galactic cosmic, and manmade sources have energies and fluxes which are capable of producing damage in space-mission payloads. NASA has initiated the construction of a ground-based Space Radiation Effects Laboratory which simulates most of the space particulate-energy spectrum, and which can be used in a radiation-research program for minimizing or eliminating deleterious radiation effects. A 600-Mev proton synchrocyclotron of variable energy and electron accelerators from 1 to 10 Mev will be included in the laboratory for accelerated testing. The plan of the proposed test areas reflects the latest advances in the state-of-the-art as it pertains to the engineering and basic experimental requirements in flexibility, radiation background levels, shielding, and isolation. The laboratory operational plan permits three Virginia institutions of higher learning to cooperate with the Langley Research Center in carrying out radiation programs. Author

N63-15223 Manchester U. (Gt. Brit.)

RESEARCH INTO METHODS OF DETERMINING THE RELATIVE HEIGHTS OF PHYSIOGRAPHIC FEATURES OF THE MOON Annual Summary Report No. 1

Zdeněk Kopal Nov. 1962 20 p refs
(Contract AF 61(052)-524)
(AFCRL-63-406)

Progress reported in lunar selenography includes: (1) redetermination of the libration constants of the moon; (2) evaluation and measurement of the Paris Observatory photographic plates of the moon (obtained between 1890 and 1910 and covering the full range of lunar libration) to determine the departures of the actual surface of the moon from a sphere; and (3) development of methods for the determination of small differences in height or depth of very shallow lunar surface features above or below the surrounding landscape. A microrelief method is described by which topographic features less than 20 meters in height and with an inclination of less than one degree can be measured significantly by comparing the photographic density of the negative on a sloping and on a level region. M.P.G.

N63-15236 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

GEOMETRICAL CHARACTERISTICS OF LUNAR ORBITS ESTABLISHED FROM EARTH-MOON TRAJECTORIES

Robert H. Tolson Apr. 1963 21 p 6 refs
(NASA TN D-1780) OTS: $0.50

An analysis has been made of the geometrical characteristics of lunar orbits which can be established from typical earth-moon transfer trajectories. An iterated two-body or patched-conic technique was used to relate the transfer-trajectory injection conditions to the selenocentric orbital parameters through a set of simultaneous transcendental equations. Solutions to these equations are presented for typical sets of injection conditions. These solutions suggest an additional simplification in the analysis which results in a simple physical understanding of the problem and also in some approximate, simple relationships between the lunar orbital parameters and the transfer-trajectory characteristics. In particular, it is shown that (unless changes in the orbital plane are instituted) there is a minimum-inclination lunar orbit which can be established. The value of this minimum inclination is given as a function of the injection conditions, and depends primarily on the injection flight-path angle and transfer-trajectory inclination to the earth-moon plane. In addition, an approximate equation is given which relates the lunar orbital inclination and nodal position to the injection conditions; hence, only one of these two lunar orbital parameters can be chosen arbitrarily. Author

30 SPACE VEHICLES

Includes: launch vehicle—spacecraft combinations; operating problems; and stability and control.

***For manned space capsules, satellites, and space probes see:* 32 Space Vehicles (Spacecraft).**

***For boosters and rockets see:* 31 Space Vehicles (Launch Vehicles).**

***For related information see:* 04 Aircraft; 08 Communication; and 22 Navigation and Guidance.**

N63-14878 Air Proving Ground Center, Eglin AFB, Fla.

STUDY OF TARGET PENETRATION PREDICTION BY HIGH SPEED AND ULTRA HIGH SPEED BALLISTIC IMPACT Final Report, 1 July 1961-28 Feb. 1963

A. G. Bilek Apr. 1963 58 p 31 refs
(Contract AF 08(635)-2155)
(APGC-TDR-63-22)

On the basis of a statistical study of existing experimental data relative to ballistic impact, engineering formulae were developed which will predict with an accuracy of 90%, (a) the depth of penetration and (b) the volume of the crater, in semi-infinite targets of common metals over a wide range of impact velocities. The application of these equations in predicting the size and velocity of projectiles impacting orbital structures is also indicated. A semi-rational penetration expression was developed from a work-energy consideration which suggests that the nonrecoverable target compression and shear strain energies may account for most of the

kinetic energy of the projectile. This dimensional model agrees quite well with the general features of, and is subject to, the same limitations as existing theoretical and empirical models. Author

N63-15074 Lincoln Lab., Mass. Inst. of Tech., Lexington

OPTICAL OBSERVATIONS OF LINCOLN LABORATORY HYPERSONIC RE-ENTRY VEHICLES TRAILBLAZERS Ic AND Id

Florence A. Wilson and John R. Bauer May 16, 1962 45 p 3 refs
[Contract AF 19(604)-7400; ARPA Order 13]
(Rept. 312G-7; AFESD-TDR-62-117)

Two Trailblazer I vehicles were fired from Wallops Island, Virginia, within approximately a three-hour period during the night of 28 August 1960. The first vehicle, Trailblazer Ic, was photographed from Arbuckle Neck, Virginia, and from Coquina Beach, North Carolina, between the heights of 152 kft and 119 kft. The reentry velocity, computed from a Super-Schmidt photograph taken at Arbuckle Neck, was about 19 kft/sec. The other vehicle, Trailblazer Id, was photographed at Wallops Island and Arbuckle Neck; due to a very short baseline between the latter two stations, the trajectory information obtained is not too reliable. The Id photographs show two trails, probably due to separation of the ablating coating from the sphere. A photometric analysis was performed on the Super-Schmidt photographs of both events. The maximum photographic magnitude for Ic was about −5.3 as compared with −1.6 for Sirius, the brightest star in the heavens, whose spectral class is AO. A typical photographic magnitude of Id was of the order $M_{pg} = 0$. Author

31 SPACE VEHICLES (LAUNCH VEHICLES)

Includes: boosters; clustered rockets; and multistage rockets.

For propulsion engines see: 27 Propulsion.

For launch vehicle - spacecraft combinations see: 30 Space Vehicles.

For related information see: 04 Aircraft; 08 Communications; and 22 Navigation and Guidance.

No abstracts in this issue.

32 SPACE VEHICLES (SPACECRAFT)

Includes: manned space capsules; satellites; and space probes.

For boosters and rockets see: 31 Space Vehicles (Launch Vehicles).

For Launch vehicle—spacecraft combinations see: 30 Space Vehicles.

For related information see: 04 Aircraft; 08 Communications; and 22 Navigation and Guidance.

N63-15055 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

VEHICLE TECHNOLOGY CONSIDERATIONS FOR A SOLAR PROBE

John A. Foschetti Washington, NASA, Apr. 1963 15 p 4 refs (NASA TN D-1747) OTS: $0.50

This report demonstrates that solar probes are feasible from the viewpoint of presently planned vehicle technology. For the early attempts, the Saturn C-1 is considered to be the most likely vehicle to place the final stage or stages into a circular orbit. If two slightly modified but identical Centaur Jr. vehicles are used for the upper stages, then this four stage configuration will be capable of placing from 400 to 2500 pounds at perihelion distances of 0.120 to 0.245 A.U. A more reliable three-stage configuration, using one Centaur Jr. for the upper stage but requiring greater modification in the original design of the vehicle, would place payloads of 400 to 2500 pounds at perihelion distances of 0.185 to 0.290 A. U. Analysis of the upper stages was based on the payload value obtained for the Saturn vehicle by using the "Generalized Powered Flight Trajectory Program." At burnout, there would be a payload of 24,612 pounds in a 100-nautical-mile parking orbit. Author

N63-15085 Iowa State U., Iowa City

CHARGED PARTICLE MEASUREMENTS IN THE VICINITY OF VENUS WITH THE SUI EXPERIMENT ON MARINER II

L. A. Frank, J. A. Van Allen, and H. K. Hills Feb. 1963 24 p
(NASA Grant NsG-233-62)
(SUI-63-6) OTS: $2.60 ph, $0.92 mf

Using a wide-angle Geiger-Mueller detector whose window thickness was 1.2 mg cm^{-2} (nominal range of 40 Kev electrons or 500 Kev protons) it was determined that there was on December 14, 1962, a complete absence of charged particles associated with the planet Venus at radial distances as small as 41,000 km on the sunward side of the planet. This result is taken to mean that the magnetosphere of Venus, if any, did not extend to that great a distance. By a similitude argument, utilizing the best current knowledge of the radiation environment of the earth, it is shown that the most plausible interpretation is that $(M_V/M_E) \leq 0.18$, where M_V and M_E are the dipole magnetic moments of Venus and Earth, respectively. The results are consistent with $M_V/M_E = 0$.

Author

N63-15107 Air Force Cambridge Research Labs. Geophysics Research Directorate, Bedford, Mass.

EVOLUTION OF THE ANNA-1 SATELLITE OPTICAL BEACON

T. Wirtanen Feb. 1963 11 p
(*Its* Instrumentation for Geophys. and Astrophys. 26; AFCRL-63-56)

Anna-1, the first geodetic satellite, carries the first optical-beacon system designed for geodetic space experimentation. During the gestation period of the Anna-1 satellite, the optical beacon underwent several major changes which were directed toward increasing the utility and reliability of the beacon, as well as its compatibility with other instruments in the Anna-1 satellite.

Author

N63-15129 National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

EFFECT OF ELECTRON IRRADIATION ON THE MECHANICAL PROPERTIES OF A COMPOSITE FOIL FOR INFLATABLE SATELLITES

Thomas G. James *In* Atomic Energy Commission. Div. of Tech. Inform., Wash., D. C. Protection Against Radiation Hazards in Space Proc. of the Symp. at Gatlinburg, Tenn., Nov. 5–7, 1962 p 260–268 1 ref (See N63-15114 11-28) OTS: $7.00
(Paper B-7)

The primary effect of electron irradiation on the Echo II skin material is an increased brittleness which leads to an early and brittle failure in both the burst-strength and ultimate-strength tests. Severe surface damage, which occurs at doses on the order of 10^{17} e/cm^2, causes mechanical damage to the aluminum-foil portion of the skin and may lead to changes in the temperature-control characteristics of the surface. Author

N63-15141 Oak Ridge National Lab., Tenn.

EXPERIMENTAL TECHNIQUES FOR THE MEASUREMENT OF NUCLEAR SECONDARIES FROM THE INTERACTIONS OF PROTONS OF A FEW HUNDRED MEV

F. C. Maienschein et al *In* Atomic Energy Commission. Div. of Tech. Inform., Wash., D. C. Protection Against Radiation Hazards in Space Proc. of the Symp. at Gatlinburg, Tenn., Nov. 5–7, 1962 p 523–594 27 refs (See N63-15138 11-28) OTS: $7.00
(Paper D-4)

In this paper are described the preparations for a set of experiments which are designed to check space-shielding calculations. The experiments are at an early stage and all information must be considered as preliminary. The approximate calculations of Alsmiller have been used to estimate that spectral measurements are most important for secondary neutrons, protons, and gamma rays arising from the interactions of incident protons in the energy range from 20 to 600 Mev. Both "thin" and "thick" targets are needed to check the two pertinent types of calculations, those for the prediction of cross sections and secondary spectra for intranuclear cascades and those for transport through shields. Previous measurements exist only for thin targets, and these are limited in energy resolution or the range of energies and angles covered. Proton recoil telescopes of two types have been studied, but current emphasis centers on a dE/dx scintillation spectrometer for the energy range above 50 Mev. Neutron time of flight over a short path is being utilized to cover the energy range from a few Mev to ~50 Mev with reasonable resolution. Finally, a set of Bonner spheres is used for the energy range below 10 Mev. The various spectrometers, together with dosimeters and threshold detectors, have been tested in feasibility studies at the Harvard University Synchrocyclotron (156-Mev protons). Results from the feasibility studies are discussed. Author

N63-15146 National Aeronautics and Space Administration, Washington, D. C.

LONG RANGE NASA SHIELDING REQUIREMENTS

J. Warren Keller *In* Atomic Energy Commission. Div. of Tech. Inform., Wash., D. C. Protection Against Radiation Hazards in Space Proc. of the Symp. at Gatlinburg, Tenn., Nov. 5–7, 1962 p 662–681 14 refs (See N63-15138 11-28) OTS: $7.00
(Paper E-1)

Several types of future missions are discussed, in a quite general manner, to establish the magnitude of the shielding problems that may exist. Also, some of the uncertainties in environmental data and shielding calculations are discussed in an effort to clear up some misconceptions as to the need for a significant shielding effort for future missions. An effort is made to outline a general approach to the space-vehicle-shielding problem. Author

N63-15147 Bendix Corp. Bendix Systems Div., Ann Arbor, Mich.

COMPARISON OF MONTE CARLO AND IONIZATION CALCULATIONS FOR SPACECRAFT SHIELDING

K. A. More and O. L. Tiffany *In* Atomic Energy Commission. Div. of Tech. Inform., Wash., D. C. Protection Against Radiation Hazards in Space Proc. of the Symp. at Gatlinburg, Tenn., Nov. 5–7, 1962 p 682–697 5 refs (See N63-15138 11-28) OTS: $7.00
(Paper E-2)

This paper compares the results of shield calculations using the Monte Carlo method and the more approximate ionization loss method. The Monte Carlo method calculates the physical interactions following nuclear collisions and ionization loss. The ionization loss method considers only ionization loss of the incident protons. On a short-term mission, the required shield is thin and the number of nuclear collisions by the incident protons is small. Therefore, both the increase in dose due to secondary particles from nuclear collisions and the decrease in dose due to nuclear absorption are small, and the dominant physical interaction is ionization loss. On the other hand, thick shields are required on long-term missions during which a large number of nuclear collisions will occur. The contribution to the astronaut's dose from the nuclear collision particles, especially the contribution from secondary neutrons, cannot be neglected. Consequently, there is a critical thickness in shield design at which shielding calculations must account for nuclear collisions. To find this thickness, calculations were performed on a spherical-shell aluminum spacecraft. Since the Monte Carlo calculation used the multigroup energy approximation, our ionization loss calculation also includes the multigroup approximation. While this method decreases the accuracy of an ionization loss calculation, its use permits more direct comparison. Author

N63-15148 Oak Ridge National Lab., Tenn.

NUCLEON-MESON CASCADE CALCULATIONS IN THE STRAIGHT-AHEAD APPROXIMATION

R. G. Alsmiller, Jr., F. S. Alsmiller, and J. E. Murphy *In* Atomic Energy Commission. Div. of Tech. Inform., Wash., D. C. Protection Against Radiation Hazards in Space Proc. of the Symp. at Gatlinburg, Tenn., Nov. 5–7, 1962 p 698–712 4 refs (See N63-15138 11-28) OTS: $7.00
(Paper E-3)

Nucleon-meson cascade calculations have been carried out for monoenergetic proton beams incident on aluminum shields. The results are used to obtain information for shielding against a solar-flare proton spectrum. A comparison between the one-dimensional cascade calculations and the more rigorous Monte Carlo calculations has been made. The two calculations are in very approximate agreement. An IBM-7090 code which is being written to solve the nucleon-meson cascade equations is described. Author

N63-15152 General Dynamics/Fort Worth, Tex.

A CALCULATIONAL PROCEDURE FOR ESTIMATING SPACE RADIATION EXPOSURE DURING LUNAR MISSIONS

R. A. Miller and W. Cranford *In* Atomic Energy Commission. Div. of Tech. Inform., Wash., D.C. Protection Against Radiation Hazards in Space Proc. of the Symp. at Gatlinburg, Tenn., Nov. 5–7, 1962 p 739–759 5 refs (See N63-15138 11-28) OTS: $7.00
(Paper E-7)

One problem concerned with manned space missions is the determination of shielding requirements for the protection of man from the hazards of space radiation. A space-trajectory-radiation-exposure procedure (STREP) has been developed to estimate the magnitude of this radiation hazard by calculating the time-integrated spectra incident on a vehicle, on a simulated trajectory, during missions in cislunar space. STREP will calculate the dose received from radiation penetrating a thin shield. A brief description is given for the trajectory and radiation computational techniques. Some results are given for calculations of the integrated spectra and dose incident on a vehicle subjected to trapped radiation, cosmic radiation, and solar-flare radiation during a lunar mission of about seven days. Author

N63-15153 Martin Co., Baltimore, Md.

RADIATION DOSAGES FROM ELECTRONS AND BREMSSTRAHLUNG IN THE VAN ALLEN BELTS

S. L. Russak *In* Atomic Energy Commission. Div. of Tech. Inform., Wash., D.C. Protection Against Radiation Hazards in Space Proc. of the Symp. at Gatlinburg, Tenn., Nov. 5–7, 1962 p 760–772 7 refs (See N63-15138 11-28) OTS: $7.00
(Paper E-8)

Radiation dose rates have been calculated for six electron spectra. The decrease in dose rate with shielding was determined—and in each case the electron dose becomes insignificant with 2 to 6 gm/cm^2 of aluminum. Electron bremsstrahlung dose rates versus absorber thickness were also calculated. Detailed dosage calculations for an Apollo-type spacecraft were made, and mission dosages for four lunar trajectories are given to show the effects of trajectory selection. These are compared with the dosages from protons and secondary neutrons in the Van Allen belt. Doses as a function of orbital altitude, of inclination, and of absorber thickness are also presented for the latest version of the inner belt. Author

N63-15155 General Dynamics/Fort Worth, Tex.
SHIELDING OF SPACE VEHICLES BY MAGNETIC FIELDS
N. Edmonson, C. D. Verwers, and F. L. Gibbons *In* Atomic Energy Commission. Div. of Tech. Inform., Wash., D.C. Protection Against Radiation Hazards in Space Proc. of the Symp. at Gatlinburg, Tenn., Nov. 5–7, 1962 p 808–818 10 refs (See N63-15138 11-28) OTS: $7.00
(Paper F-2)

A program has been initiated to study various aspects of magnetic shielding of space vehicles. In one phase of the program, a procedure has been formulated and coded for the IBM-7090 computer for rapidly computing the field of an optimized superconducting solenoid. In another phase, samples of NbZr wire have been irradiated with neutral particles from two sources. Preliminary results are now available. Irradiation with 10^{11} neutrons per cm^2 from the D-T reaction showed no change in the critical current versus magnetic-field curve. Irradiation with 10^{16} neutrons (>2.9 Mev) per cm^2 showed a slight downward shift in the critical current. Author

N63-15156 General Dynamics/Fort Worth, Tex.
THE COMBINATION OF ACTIVE AND PASSIVE SHIELDING
J. M. Norwood *In* Atomic Energy Commission. Div. of Tech. Inform., Wash., D. C. Protection Against Radiation Hazards in Space Proc. of the Symp. at Gatlinburg, Tenn., Nov. 5–7, 1962 p 819–828 6 refs (See N63-15138 11-28) OTS: $7.00
(Paper F-3)

It is conceivable that improved shielding of space vehicles against high-energy charged-particle radiation can be obtained by combining active and passive shielding. Methods of shielding calculations, and some preliminary observations pertaining to active-passive shielding, are given. An analysis based upon the field of a magnetic dipole indicates that weight savings in bulk shielding can be accomplished. Author

N63-15157 California U., Berkeley. Lawrence Radiation Lab.
TECHNIQUES USED IN SHIELDING CALCULATIONS FOR HIGH-ENERGY ACCELERATORS: APPLICATIONS TO SPACE SHIELDING
Roger Wallace and Charles Sondhaus *In* Atomic Energy Commission. Div. of Tech. Inform., Wash., D.C. Protection Against Radiation Hazards in Space Proc. of the Symp. at Gatlinburg, Tenn., Nov. 5–7, 1962 p 829–851 13 refs (See N63-15138 11-28) OTS: $7.00
(Paper F-4)

The prediction for the secondary neutron spectrum produced inside of a thick shield is described. The multiplicity of cascade and evaporation secondaries, as well as subsequent moderation of the secondary spectrum, is described quantitatively. Experimental thick-target neutron yields, as well as Monte Carlo cascade data, are the basis for these estimates. Author

N63-15166 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
THE OBSERVATORY GENERATION OF SATELLITES Session II of a Special Astronautics Symposium held at Franklin Institute, Philadelphia, Dec. 27, 1962, during the 129th Annual Meeting of the American Association for the Advancement of Science
Washington, NASA. Office of Sci. and Tech. Inform., Mar. 1963 62 p 15 refs
(NASA SP-30) GPO: $0.50

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3. MISSION OF THE ADVANCED ORBITING SOLAR OBSERVATORY John C. Lindsay (NASA. Goddard Space Flight Center) p 25–29 3 refs (See N63-15169 11-32)
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6. THE ENGINEERING DESIGN OF THE ORBITING ASTRONOMICAL OBSERVATORY Walter H. Scott, Jr. (Grumman Aircraft Engr. Corp.) p 53–62 3 refs (See N63-15172 11-32)

N63-15167 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
THE MISSION OF THE ORBITING GEOPHYSICAL OBSERVATORIES
Wilfred E. Scull *In its* Observatory Generation of Satellites Session II of a Special Astronautics Symp. held at the Franklin Inst., Phila., Dec. 27, 1962, during the 129th Annual Meeting of the American Assoc. for the Advan. of Sci. p 1–10 (See N63-15166 11-32) GPO: $0.50

The Orbiting Geophysical Observatories program has two objectives. The primary objective is to conduct large numbers of significant, diversified experiments for making scientific and technological measurements within the earth's atmosphere, the magnetosphere, and cislunar space to obtain a better understanding of earth-sun relations and of the earth as a planet. A secondary objective is to design, develop, and have available for launching at regular intervals a standard observatory-type oriented spacecraft consisting of a basic system design that can be used repeatedly to carry large numbers of easily integrated experiments in a wide variety of orbits. As a design objective for the standard spacecraft, it is desired that the spacecraft be capable of reliable operation for a period up to one year in a wide variety of orbits from near-earth circular to highly elliptical cislunar. The current program consists of two missions: the Eccentric Orbiting Geophysical Observatory (EGO), which will be launched from the Atlantic Missile Range in late 1963; and the Polar Orbiting Geophysical Observatory (POGO), which will be launched in early 1964 from the Pacific Missile Range. Author

N63-15168 Space Technology Labs., Inc., Los Angeles, Calif.
THE ENGINEERING DESIGN OF THE ORBITING GEOPHYSICAL OBSERVATORIES
George E. Cleghorn *In* NASA. Goddard Space Flight Center Observatory Generation of Satellites Session II of a Special Astronautics Symp. held at the Franklin Inst., Phila., Dec. 27, 1962, during the 129th Annual Meeting of the American Assoc. for the Advan. of Sci. p 11–23 2 refs (See N63-15166 11-32) GPO: $0.50

The Orbiting Geophysical Observatory (OGO) spacecraft standard configuration has been designed to provide an attitude-stabilized platform with the proper mechanical and thermal environment, electric power, and telemetry equipment to accommodate a variety of experiments on each launch. Two Solar Oriented Experiment Packages (SOEP) for each solar array are provided for those experiments that must be oriented toward the sun; two Orbit Plane Experiment Packages (OPEP) are mounted on a shaft perpendicular to the solar array shaft for those experiments that must be oriented parallel to the plane of the orbit. Long and short booms are

extended from the body of the spacecraft to accommodate experiments whose sensitivity or look angle requires that they be isolated from other portions of the observatory; and two opposing faces of the spacecraft body are provided for instrumentation that must either look toward or directly away from the earth. In addition, a portion of the interior has been kept clear of spacecraft equipment to accommodate large experiments. The engineering design of the supporting structure, thermal control system, power supply, attitude control system, and communications and data handling equipment includes a sufficient margin to permit the operation of the spacecraft's subsystems in a variety of orbits. M.P.G.

N63-15169 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

MISSION OF THE ADVANCED ORBITING SOLAR OBSERVATORY

John C. Lindsay *In its* Observatory Generation of Satellites Session II of a Special Astronautics Symp. held at the Franklin Inst., Phila., Dec. 27, 1962, during the 129th Annual Meeting of the American Assoc. for the Advan. of Sci. p 25–29 3 refs (See N63-15166 11-32) GPO: $0.50

The general mission of the Advanced Orbiting Solar Observatories (AOSO) is to provide the sophisticated spacecraft necessary to advance the study of earth-sun relations and to study the sun as a star from the vantage point of the spacecraft orbit. Although difficulties arise in attempting to describe the AOSO mission more specifically because the anticipated launch date of the first AOSO (Helios) is not until 1966, a study of solar flares is presented as the type of problem that scientists might attempt to solve using experiments on Helios. M.P.G.

N63-15170 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

ONE APPROACH TO THE ENGINEERING DESIGN OF THE ADVANCED ORBITING SOLAR OBSERVATORY

Adolph J. Cervenka *In its* Observatory Generation of Satellites Session II of a Special Astronautics Symp. held at the Franklin Inst., Phila., Dec. 27, 1962, during the 129th Annual Meeting of the American Assoc. for the Advan. of Sci. p 31–43 (See N63-15166 11-32) GPO: $0.50

The Advanced Orbiting Solar Observatory (AOSO) is being designed by NASA specifically for extensive and detailed studies of the sun. The field of view of this observatory will extend to a distance of about 10 sun diameters from the center of the disk; yet a 5-arc-second pointing precision permits some 400 separate observations in one pass across the sun's diameter. The AOSO can carry substantially heavier experiment payloads than the OSO, and its near-polar orbit provides these experiments with continuous sunlight for 9 months after launch. This paper summarizes the design study conducted by NASA's Goddard Space Flight Center, in which emphasis was placed on stabilization and control of the spacecraft—a critical design area. In particular, suntracker requirements were investigated in detail, and the conceptual design of a tracker produced in the study is described. The sun-tracker work included experimental demonstrations of the feasibility and accuracy of GSFC's concept, and it appears that the ± 2-arc-second accuracy required of a sun tracker can be attained. In other subsystem areas, such as communications, data handling, and power supply, maximum use will be made of technology and hardware developed in the OGO, OAO, and other programs. The communications and data-handling equipment being developed for OGO generally will satisfy AOSO requirements. Author

N63-15171 National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

THE MISSION OF THE ORBITING ASTRONOMICAL OBSERVATORY

Robert R. Ziemer and James E. Kupperian, Jr. *In its* Observatory Generation of Satellites Session II of a Special Astronautics Symp. held at the Franklin Inst., Phila., Dec. 27, 1962, during the 129th Meeting of the American Assoc. for the Advan. of Sci. p 45–51 7 refs (See N63-15166 11-32) GPO: $0.50

The basic reason for developing an Orbiting Astronomical Observatory (OAO) is the possibility of celestial observation without interferences due to the atmosphere, thereby: (1) permitting the continuous study of the ultraviolet and infrared components of celestial electromagnetic radiation, and (2) eliminating the twinkling due to the atmosphere and the interference due to reflected light in the night sky. The primary experiments chosen for the first three OAO satellites are all directed toward the ultraviolet portion of the spectrum. The first flight will carry the Project Celescope experiment, prepared by the Smithsonian Astrophysical Observatory to obtain data for an all-sky ultraviolet stellar map, and the broadband photometry experiment, prepared by the University of Wisconsin, to measure the intensity and distribution of stellar energies from 3000A to 800A. The second observatory will contain a system for the study of absolute spectrophotometry being prepared by the Goddard Space Flight Center. The third observatory will carry the Princeton University equipment for the study of the composition and physical conditions of interstellar matter. M.P.G.

N63-15172 Grumman Aircraft Engineering Corp., Bethpage, N.Y.

THE ENGINEERING DESIGN OF THE ORBITING ASTRONOMICAL OBSERVATORY

Walter H. Scott, Jr. *In* NASA. Goddard Space Flight Center Observatory Generation of Satellites Session II of a Special Astronautics Symp. held at the Franklin Inst., Phila., Dec. 27, 1962, during the 129th Annual Meeting of the American Assoc. for the Advan. of Sci. p 53–62 3 refs (See N63-15166 11-32) GPO: $0.50

The Orbiting Astronomical Observatory (OAO) is designed to provide an accurately stabilized, unmanned platform for astronomical observations from well above the earth's atmosphere. Of primary immediate interest is the observation of stellar radiation in the ultraviolet range, which is severely limited even in balloon experiments because of absorption in the ozone layers. The OAO is a 3600-pound spacecraft that will be placed in orbit by an Atlas Agena D. It can handle optical systems up to 48 inches in diameter, 10 feet in length, weighing 1000 pounds. The key design requirements of the spacecraft are discussed. The reasons behind the configuration are then explained, followed by a discussion of the major subsystems showing how they have been designed to meet the exacting requirements of astronomical observation. Author

N63-15205 Smithsonian Astrophysical Observatory, Cambridge, Mass.

ON SOME SINGULAR ORBITS OF AN EARTH-MOON SATELLITE WITH A HIGH AREA-MASS RATIO

G. Colombo and D. A. Lautman Nov. 9, 1962 17 p 4 refs
(NASA Grant NsG-87-60)
(SAO Special Rept. 107) OTS: $1.60 ph, $0.80 mf

Three basic capture orbits for an earth-moon satellite of a high area-mass ratio are calculated and variations are given. Use of these orbit calculations would make it possible to put a balloon-type configuration into orbit close around the lunar surface. This operation would yield much useful information about the moon's gravitational field and the interplanetary space around the moon. It also would allow the investigation of the moon's radiation pressure as to possible mechanism for transferring meteoritic material to the vicinity of the earth. D.E.R.

N63-15209 Polish Academy of Sciences. Committee on International Geophysical Cooperation, Warsaw

BIULETYN POLSKICH OBSERWACJI SZTUCZNYCH SATELITOW, NR 6 (BULLETIN OF POLISH OBSERVATIONS OF THE ARTIFICIAL SATELLITES, NO. 6)

Ludoslaw Cichowicz, ed. June 1962 97 p refs In Polish; English and Russian table of contents and summaries

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N63-15210 Czetochowska Technical U. (Poland)

PLANISFERA SATELITARNA (THE SATELLITIC PLANISPHERE)

Roman Janiczek *In* Polish Academy of Sciences. Committee on International Geophysical Cooperation, Warsaw Biuletyn Polskich Obserwacji Sztucznych Satelitow, Nr 6 (Bulletin of Polish Observations of the Artificial Satellites, No. 6) June 1962 p 10–17 In Polish; English and Russian summaries (See N63-15209 11-32)

The satellitic planisphere consists of the following elements: (a) the map of the sky (firmament); (b) the satellite's projection for the definite value of the angle of the orbit's inclination to the equator, plotted on a transparent disk; (c) the horizontal system's grid plotted on the transparent disk; and (d) the angle distances γ for the definite satellite s situation plotted on a transparent lap. The planisphere makes it possible to mark out quickly the satellite's apparent trajectory on the firmament. Flaring the adequate number of laps, it is possible to mark out the elements of the circular satellite's orbit. To mark out the satellite's occultations, it is necessary to have the plansiphere, which consists of the map of the sky in the ecliptic system as well as the scheme of the centric circles representing the borders of the earth's shade for different heights, plotted on the transparent disk. Author

N63-15211 People's Astronomical Observatory, Gdansk (Poland)

METODY OBSERWACJI STACJONARNYCH SATELITÓW ZIEMI (METHODS FOR OBSERVATION OF STATIONARY EARTH SATELLITES)

Leon Wohlfeil *In* Polish Academy of Sciences. Committee on International Geophysical Cooperation, Warsaw Biuletyn Polskich Obserwacji Sztucznych Satelitów, Nr 6 (Bulletin of Polish Observations of the Artificial Satellites, No. 6) June 1962 p 18–27 In Polish; English and Russian summaries (See N63-15209 11-32)

The first part of the article consists of data showing how the conditions for the artificial satellite's observations (zenith distance, apparent speed) change in dependence on its orbit elements. The author presents the characteristic features of the 24-hour satellite's behavior, and he considers the different cases of the apostasy from the ideal stability. The second part of the article discusses the means for the 24-hour satellite's observation, with the help of: a refractor with a filar micrometer, the "celostat," and the astrograph. The third part consists of considerations on the 24-hour satellite's conditions of visibility. Author

N63-15243 Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

STERILIZATION OF UNMANNED PLANETARY AND LUNAR SPACE VEHICLES—AN ENGINEERING EXAMINATION

L. D. Jaffe Jan. 7, 1963 Revised Mar. 25, 1963 23 p 40 refs For document before revision see N63-13440 08-16

(NASA Contract NAS7-100)

(JPL-TR-32-325, Rev.) OTS: $2.60 ph, $0.89 mf

The probability of achieving and maintaining sterility of an unmanned spacecraft with various proposed procedures is examined in detail. The required degree of assurance against infection of a planet with Earth organisms is also considered. For Mars landers and orbiters, sterilization by dry heat, with no subsequent access to the spacecraft, is found to be desirable. Glove-box sterile assembly is not recommended for these missions; sterile assembly in a hood or in the open seem wholly unsatisfactory. For Venus landers and orbiters, sterilization standards can be somewhat relaxed; for the Moon, sterilization appears unnecessary, but microbial counts should be kept low. Sterilization lowers spacecraft and system reliability. It reduces the chance of launching within periods fixed by astronomical constraints, and increases costs. Author

N63-15244 Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

RANGER PREFLIGHT SCIENCE ANALYSIS AND THE LUNAR PHOTOMETRIC MODEL

A. G. Herriman, H. W. Washburn, D. E. Willingham Jan. 7, 1963, Revised Mar. 11, 1963 40 p 11 refs For document before revision see N63-13449 08-29

(NASA Contract NAS7-100)

(JPL-TR-32-384, Rev.) OTS: $3.60 ph, $1.40 mf

A photometric model of the lunar mare surface is presented. The lighting parameters for the Ranger 3, 4, and 5 TV system are developed using the photometric model, and related to the system parameters. The interactions of the TV constraints with those imposed by the other experiments and by trajectory characteristics are discussed in detail, and the use of plastic spheres to show graphically the interrelationships among the parameters is described. Author

33 STRESSES AND LOADS

Includes: fatigue; vibration; flutter; and structural tests.

For related information see: 02 Aerodynamics of Bodies, Combinations, and Internal Flow; 03 Aerodynamics of Wings and Control Surfaces; and 34 Structural Design.

N63-14725 Gt. Brit. Ministry of Aviation. Technical Information and Library Services, Mottingham

METHODS OF TESTING FOR CREEP IN MODELS OF TURBINE DISCS (METODIKA ISPYTANII NA POLZUCHEST' MODELEI TURBINNYKH DISKOV)

S. I. Matveev Dec. 1962 22 p 4 refs Transl. from Vopr. Metalloved. Kotloturbinnykh Materialov, Moscow, 1955 p 86–103 (TILT/T-4957)

The model test discs are rotated inside a welded steel test chamber, strong enough to withstand discs. The chamber is electrically heated over the range 300° to 650° C. Construction and operation of the equipment are described. Types of stress arising in turbine discs are analyzed; in the tests, initial and final radial and tangential stresses are measured. Results are tabulated and graphed. Author

N63-14742 Martin Co., Denver, Colo.

EXPERIMENTAL BUCKLING OF CLOSED SHELLS OF REVOLUTION Research Report

John J. Burns, Jr. Mar. 1963 58 p 1 ref

(R-63-4)

Experimental results of the buckling of closed shells of revolution subjected to static and impulsive external pressures are presented. Conclusions are drawn as to the effects of the material yield strength on the buckling strength of shells. Conclusions are also made in regard to the buckling mode shape and number of buckles obtained under impulsive loads. Author

N63-14747 David Taylor Model Basin. Structural Mechanics Lab., Washington, D.C.

ELASTIC LOBAR BUCKLING OF RING-SUPPORTED CYLINDRICAL SHELLS UNDER HYDROSTATIC PRESSURE

Thomas E. Reynolds Sept. 1962 110 p 44 refs
(DTMB-1614)

A small-deflection analysis is developed for the elastic interbay buckling of ring-stiffened cylindrical shells in which the influence of the rings on deformations before and during buckling is considered. Tests were carried out with a machined, ring-stiffened cylinder (BR-4B) subjected to external hydrostatic pressure. Collapse was initiated by elastic asymmetric buckling of the shell. Strain measurements taken during the test demonstrated that the Southwell method of determining buckling strength nondestructively is applicable in the case of interbay buckling. The results of this and three other tests of machined cylinders are in good agreement with the theory. While the Von Mises theory is inaccurate for closely spaced rings, its continued application for estimating elastic buckling strength is probably justified, since it is always conservative and can be represented in a simple form. Author

N63-14748 Bureau of Mines. Explosives Research Lab., Pittsburgh, Pa.

HYPERVELOCITY IMPACT PHENOMENA Quarterly Report, December 1, 1962–February 28, 1963

Richard W. Watson, Karl R. Becker, and Frank C. Gibson Mar. 18, 1963 14 p 3 refs

Work was continued on the character of the spall produced by high-velocity projectiles penetrating thin metallic targets. The projectile velocity range has been increased to 5.0 km/sec, and both the spatial distribution of spall numbers and distribution of spall velocities are discussed and compared with previous data. A.R.B.

N63-14749 Polish Academy of Sciences, Warsaw

ABSTRACTS OF REPORTS OF THE SECOND CONFERENCE ON NONLINEAR VIBRATIONS [WARSAW, SEPTEMBER 18–21, 1962]

I. Ballo (Czechoslovak Acad. of Sci., Prague) et al [1962] 147 p 144 refs

Abstracts on the following topics have been included in this report on nonlinear vibrations: the dynamical properties of nonlinear systems with shock vibration damper; a method of solution to the computing system of nonlinear differential equations of computing set of variables; the behavior of solutions of the nonlinear system with two degrees of freedom; the analysis of processes arising in nonlinear electromechanical systems with two degrees of freedom; integral manifolds of nonlinear vibration systems; problems of nonlinear vibrations systems; recurrency formula in nonlinear systems; asymptotic properties of systems with a small time lag; superposition techniques in certain nonlinear systems; behavior of dynamical systems near the limit of stability region; behavior of certain nonlinear mechanical systems which contain delayed quantities; the problem of definition of roughness structural stability of a dynamical system in a bounded closed domain; the analogy of nonlinear system to classical dynamics; the number of topological types of polynomial differential systems; and free and forced vibrations of strongly nonlinear systems with many degrees of freedom. A.R.B.

N63-14763 National Advisory Committee for Aeronautics. Langley Aeronautical Lab., Langley Field, Va.

EFFECT OF HINGE-LINE POSITION ON THE OSCILLATING HINGE MOMENTS AND FLUTTER CHARACTERISTICS OF A FLAP-TYPE CONTROL AT TRANSONIC SPEEDS

Robert F. Thompson and William C. Moseley, Jr., Washington, NACA, June 10, 1957 54 p 11 refs
(NACA RM L57C11) OTS: $5.60 ph, $1.82 mf (Declassified)

Free-oscillation tests were made to determine the dynamic hinge-moment characteristics of a trailing-edge, flap-type control surface with various hinge-line positions. The essentially full-span control was tested on a 4-percent-thick, low-aspect-ratio wing as a reflection plane configuration in the Langley high-speed 7- by 10-foot tunnel. The total control chord was 30 percent of the wing chord, and ratios of balance chord to flap chord rearward of the hinge line of 0.20, 0.35, and 1.00 are reported. Test parameters covered a Mach number range from 0.40 to 1.02, control oscillating amplitudes of about 10° or larger, angles-of-attack of 0° and 6°, and a range of control-reduced frequencies. Static data were also obtained for the three control hinge-line positions, and results are compared with existing theories. Results show that oscillating amplitude has a large effect on the control aerodynamic damping derivative, and that the damping is unstable in the test Mach number range above about 0.90 for the hinge positions tested. Damping was generally stable at Mach numbers below 0.90, although it was unstable at subsonic speeds for high oscillation amplitudes of the control hinged at the midchord. When the total damping of the control system (nonaerodynamic plus aerodynamic) was unstable, the control fluttered with only one degree-of-freedom, and at transonic speeds the flutter amplitude was decreased by a rearward movement of the hinge line. Author

N63-14772 National Aeronautics and Space Administration. Langley Research Center, Langley Field, Va.

AN EXPERIMENTAL STUDY OF THE FLUTTER OF SAILS HAVING A DELTA PLANFORM TESTED FROM A MACH NUMBER OF 0.1 TO A MACH NUMBER OF 1.9

Robert W. Hess Washington, NASA, Mar. 1961 40 p 2 refs
(NASA TM X-355) OTS: $3.60 ph, $1.40 mf (Declassified)

Sails having a delta planform with a leading-edge sweep angle of 55° and a span of about 8 inches were fluttered through a range of angle-of-attack and dynamic pressure at subsonic speeds and transonic speeds. Larger sails with a span of about 18 inches were tested at a Mach number of 1.9. Two types of flutter were encountered during the tests, local flutter and full-sail flutter. Local flutter was confined to a small percentage of the total sail area whereas full-sail flutter involved the whole sail. For a given set of aerodynamic and structural conditions, flutter was found to occur when the angle-of-attack was reduced to a sufficiently low, positive value. In general, flutter occurred below an angle-of-attack of about 2° to 4° at very low dynamic pressures (10 lb/sq ft to 20 lb/sq ft) and below about 10° in the high dynamic-pressure range (120 lb/sq ft to 200 lb/sq ft). The angle-of-attack at flutter varied rapidly with dynamic pressure in the low dynamic-pressure range and approached a constant angle-of-attack in the high dynamic-pressure range. No effect of Mach number could be determined. The variation of the camber of the sails affected the angle-of-attack at which flutter occurred and obscured the interpretation of the results of tests designed to determine the effects of sail porosity and density. This type of lifting surface appears to be usable from a flutter standpoint with a limitation in the angle-of-attack. Author

N63-14797 Midwest Research Inst. Mathematics and Physics Div., Kansas City, Mo.

RESEARCH ON THE MECHANISMS OF FATIGUE IN ULTRA SMALL SPECIMENS Quarterly Progress Report No. 7, Dec. 1, 1962–Mar. 1, 1963

J. C. Grosskreutz, Mar. 29, 1963 15 p 10 refs
(Contract AF 33(616)-7858)

Experiments designed to test the validity of observations in fatigued aluminum have been carried out. Definitive experiments are underway to show directly the path of a fatigue crack through subdivided material. Moreover, the significance of subgrains to fatigue fracture is being investigated on a larger scale by means of a survey of fatigue-crack-tip deformation in various metals and alloys. Author

N63-14833 Massachusetts Inst. of Tech. Hydrodynamics Lab., Cambridge

FLOW-INDUCED VIBRATION OF FLAT PLATES: THE MECHANISM OF SELF-EXCITATION

P. S. Eagleson, J. W. Daily, and G. K. Noutsopolous Feb. 1963 107 p 44 refs

(Contract Nonr-1841(21))

(Hydrodynamics Lab. Rept.-58, R-62-36)

Study is made of the vibrational behavior of flat plates when placed parallel to a uniform stream and allowed one degree of freedom torsional oscillation around a vertical axis through their leading edge. Major conclusions of this study are: (1) Controlled variation of the system parameters, i.e., increasing the combined structural-viscous damping and increasing the steady-state Strouhal number, allows design of a system in which self-excitation is avoided. (2) The primary role of trailing-edge geometry in flow-induced vibrations is in determining the free-stream velocity for resonant response through establishment of the steady-state Strouhal number. (3) Self-excitation, the increase in moment coefficient with increasing vibrational amplitude, is due both to increasing two-dimensionality of the wake and to increasing strength of the discrete vortices. Author

N63-14834 Toronto U. Inst. of Aerophysics (Canada)

AN EXPERIMENTAL INVESTIGATION OF THE SOUND GENERATED BY THIN STEEL PANELS EXCITED BY TURBULENT FLOW (BOUNDARY LAYER NOISE)

G. R. Ludwig Nov. 1962 123 p 28 refs

(Contract AF 49(638)-249; Grant AF-AFOSR-62-267 and DRB-Grant-9551-02)

(UTIA-87)

Investigations were made of sound generated by thin steel panels, flush mounted in a wall of a turbulent flow channel. Two accoustically quieted air ducts provided the flow. The mean-square wall pressures, spectral density of the wall pressures, and two point space correlations at the wall were measured with the use of pin-hole microphones as pressure transducers. A resonant response technique was used to measure damping on the panels in their test environment. Empirical scaling parameters for the spectral density of the radiated sound are presented. Extrapolation of test data suggests that flexible panels may prove to be the most efficient generators of aerodynamic noise over a wide range of these parameters. C.L.W.

N63-15206 Bettis Atomic Power Lab., Westinghouse Electric Corp., Pittsburgh, Pa.

A NUMERICAL SOLUTION FOR PLATE BENDING PROBLEMS

D. S. Griffin Feb. 1963 53 p 19 refs

(Contract AT(11-1)-GEN-14)

(WAPD-230) OTS: $1.25

A method is presented for obtaining the deflections of a thin elastic plate due to a transverse load and a combination of four boundary conditions, including elastic supports. The method, based on finite differences, makes efficient use of the digital computer in solving for the irregular boundary shapes often encountered in engineering design. Results are compared with known solutions, and a new solution is presented. Author

N63-15208 Space Technology Labs., Inc., Redondo Beach, Calif.

BUCKLING OF SHELLS UNDER DYNAMIC LOADS Second Quarter Report, Dec. 1, 1962-Feb. 28, 1963

L. R. Koval and J. P. O'Neill [1963] 14 p 3 refs

(NASA Contract NASw-504)

(Rept. 8688-6001-RU000) OTS: $1.60 ph, $0.80 mf

A summary of the progress in this reporting period is as follows: (1) The equations previously formulated in the theoretical analyses have been revised in order to satisfy a periodicity requirement on the tangential displacement of the shell wall. (2) The single-ended two-plate electrostatic loading system was found to have the characteristics previously predicted; however, the three-plate so-called "push-pull" system was shown by test to differ from predictions based on the literature dealing with electrostatic loudspeakers. An extensive analysis was made of electrostatic drive systems for dynamically loading structural surfaces. (3) An experimental investigation was made to determine the configuration and materials allowed for the electrostatic loading apparatus, and the vacuum equipment requirements for preventing electrical breakdown. (4) Both the electrostatic loading system and the vacuum chamber were rebuilt as a result of 2 and 3 above. Author

N63-15214 University Coll., Galway (Ireland)

IMPACT RESISTANCE OF PLAIN, REINFORCED AND PRESTRESSED CONCRETE BEAMS Final Technical Report, 1 Aug. 1961 to 1 Aug. 1962

J. D. O'Keefe and P. J. Faherty Sept. 1962 72 p 30 refs

(Contract DA-91-591-EUC-1823)

An extensive range of reinforced concrete beams was tested and the results of the various measurements were analyzed. The steel withstood tensile stresses up to 1.4 times the static yield stress, irrespective of the amount of steel in the beam section. In heavily reinforced beams, the stresses were up to three times the static yield value without yield of the steel. The concrete withstood dynamic tensile stresses of between 2,000 and 3,600 p.s.i., and compressive stresses of between 1.7 and 1.9 times the cube strength under the influence of simple impacts. The resistance of beams with percentages of bottom steel lying between 0.3% and 1.4% was directly dependent on the percentage of bottom steel when there was sufficient top steel in the section. Better distribution of bottom steel produced improved resistance to impact. For the same cumulative energy absorbed by a beam, a single major impact was more detrimental than the cumulative effect of minor impacts. Author

N63-15231 Japan. Ministry of Transportation. Transportation Technical Research Inst., Tokyo

THEORETICAL RESEARCH ON PROPAGATION OF BRITTLE FRACTURE (FOURTH REPORT--STRAIN ENERGY RELEASE RATE FOR AN ENLARGING SLIT AT CONSTANT SPEED)

Yoshio Akita and Kazuo Ikeda Nov. 1962 17 p 9 refs

(TTRI-54)

In general, the rates of released-elastic-strain energy, kinetic energy, and work required for creating new surfaces are the determinate factors governing the propagation of brittle fracture. In this report, the release rate of elastic-strain energy in a plate having an enlarging slit at constant speed was calculated by using the dynamical stresses around the tip of the slit which were obtained in a previous report. The release rate of elastic-strain energy decreases with crack-speed ratio. Author

N63-15232 Japan. Ministry of Transportation. Transportation Technical Research Inst., Tokyo

THEORY OF BRITTLE CRACK INITIATION AND PROPAGATION--A THEROETICAL ANALYSIS OF ESSO TEST

Yoshio Akita and Kazuo Ikeda Nov. 1962 19 p 26 refs

(TTRI-55)

Brittle crack initiation and propagation are investigated theoretically from a viewpoint of dynamics. A dynamically modified Griffith-Orowan energy condition, in which the effect of crack speed on rates of released-elastic-strain energy and kinetic energy are taken into account, must be satisfied for brittle crack initiation and propagation. The rate of plastic work caused by yielding around the tip of a crack must also be considered for crack initiation. The ESSO test, in which tension and impact are needed for crack initiation, can be interpreted by this theory. Author

N63-15239 Advisory Group for Aeronautical Research and Development, Paris (France)

FATIGUE TESTING AND ANALYSIS OF RESULTS

W. Weibull, ed. (Bockamöllan, Sweden) Oxford, N.Y., Pergamon Press, 1961 320 p 969 refs

Available from Pergamon Press: 84 s.

This book on fatigue testing covers the following areas: symbols and nomenclature; fatigue testing methods; fatigue testing machines and equipment for testing parts and assemblies; instruments and measuring devices; design, preparation, measurement, and protection of test pieces; planning test programs; and factors affecting test results, and presentation and analysis of results.

R.C.M.

34 STRUCTURAL DESIGN

Includes: structural elements; and weight analysis.

For related information see: 02 Aerodynamics of Bodies, Combinations, and Internal Flow; 03 Aerodynamics of Wings and Control Surfaces; and 33 Stresses and Loads.

N63-14738 Naval Research Labs., Washington, D.C.

NEW PRINCIPLES FOR FRACTURE-SAFE DESIGN OF STEEL STRUCTURES

W. S. Pellini and P. P. Puzak *In its* Report of NRL Progress Mar. 1963 p 9–48 62 refs (See N63-14736 11-05) OTS: $1.25

A new procedure, based on the concept of the fracture analysis diagram, has been evolved for the engineering design of fracture-safe steel structures representing weldments, forgings, castings, and combinations of these. The procedure is applicable to all intermediate- and low-strength steels which have distinct transition temperature features, i.e., excepting the ultrahigh-strength types which have poorly defined, low-slope, Charpy-V transition curves. The fracture analysis diagram concept represents a consolidation of the available knowledge concerning flaw size, stress level, and temperature requirements for the initiation and propagation of brittle fractures. Service failure and structural test data are given as documentation of the validity of the described procedures to provide fracture-safe design. Author

N63-14969 Aerospace Medical Div. Aeromedical Research Lab. (6571st), Holloman AFB, N. Mex.

THE FLYWHEEL AS A CENTRIFUGAL ACCELERATOR

Hubert C. Feder Apr. 1963 20 p 3 refs

(ARL-TDR-63-9)

Subjected to investigation is a flywheel accelerator as a component of a 160- to 200-foot-diameter circular track. The 22-spoke, box-construction flywheel could be made from commercially available steel plates. Based on optimal design conditions, the upper application limit, governed by the welding property of the material used, was found to be a test weight—load factor capacity of 230,000 pound to 300 g. The discussion, based on a linear dependence of flywheel weight, moment of inertia, power and cost on test weight, and cross section of box members at constant radius and stress, shows that the lower application limit of the flywheel reaches far into the application range of proposed, arm-type centrifuges, and that the flywheel is a logical necessity if the test capacity of existing centrifuges needs to be exceeded. Author

N63-14983 Naval Research Lab., Washington, D.C.

FRACTURE ANALYSIS DIAGRAM PROCEDURES FOR THE FRACTURE-SAFE ENGINEERING DESIGN OF STEEL STRUCTURES

W. S. Pellini and P. P. Puzak Mar. 15, 1963 55 p 25 refs

(NRL-5920) OTS: $1.50

A new procedure is described for the engineering design of fracture-safe steel structures representing weldments, forgings, castings, and combinations of these. The procedure is applicable to all steels which have distinct transition-temperature features, i.e., excepting the ultrahigh strength types which have poorly defined, low-slope Charpy V transition curves. The new procedure is based on the concept of the fracture analysis diagram, which represents a consolidation of the available knowledge concerning flaw size, stress, and temperature requirements for the initiation and propagation of brittle fractures. The bases for the development of the diagram are explained. Extensive failure and structural test data are provided as documentation of the validity of the described procedures. The practical engineering use of the fracture-analysis diagram is based on the determination of a simple parameter—the NDT temperature of the steel. All other required information involves elements which are normal considerations in design of engineering structures. Author

N63-15099 Lockheed-Georgia Co. Scientific and Technical Information Dept., Marietta

BIBLIOGRAPHY ON AERONAUTICAL WEIGHT ESTIMATION AND CONTROL [1957-MAY 1962]

C. D. Rife comp. June 20, 1962 15 p 139 refs

This bibliography on aircraft weight control covers the following: estimations, materials, general design, electrical system design, hydraulic system design, structural design, mathematics, and lightweight components. R.C.M.

N63-15154 United Nuclear Corp. Development Div., White Plains, N.Y.

SYNTHESIS OF MINIMUM WEIGHT PROTON SHIELDS

A. D. Krumbein, P. S. Mittelman, E. S. Troubetzkoy, F. Nakache, and J. Celnik *In* Atomic Energy Commission. Div. of Tech. Inform., Wash., D.C. Protection Against Radiation Hazards in Space Proc. of the Symp. at Gatlinburg, Tenn., Nov. 5–7, 1962 p 773–793 3 refs (See N63-15138 11-28) OTS: $7.00

(NASA Contract NAS8-2658)

(Paper E-9)

A shield optimization technique, originally developed for reactor shields, has been applied to proton shields. The cases of both spherical and nonspherical shields have been studied, and the effects of certain special constraints and of secondary neutroas have been included in the analysis. The method indicates which materials should go into making up the minimum-weight shield and what their order and the thickness of each material should be. The amount of weight saved is found to be a function of the radius of the shielded void and of the specified attenuation required. Author

N63-15233 Japan. Ministry of Transportation. Transportation Technical Research Inst., Tokyo

DESIGN DIAGRAMS OF THREE-BLADED CONTROLLABLE PITCH PROPELLERS

Kiyoshi Tsuchida and Atsuo Yazaki Jan. 1963 14 p

(TTRI-57)

Test results and design diagrams for models of three-bladed controllable pitch propellers are reported. The diameter of the propellers is 0.22 meters and the boss ratio is 0.34. The blade sections resemble Wageningen B-series aerofoils. There are two series of propellants with expanded blade area ratios of 0.35 and 0.50; four model propellers having the constant initial pitch ratios of 0.4, 0.6, 0.8, or 1.0, were manufactured for each of the series of propellants. Open water tests have been conducted. D.E.R.

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